OAGM/AAPR & ARW 2016
PROGRAMME / ABSTRACTS

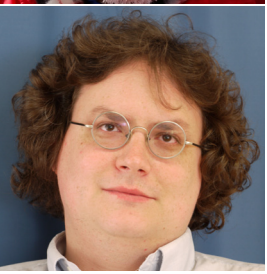
OAGM & ARW Joint Workshop on „Computer Vision and Robotics“

11th – 13th May 2016
University of Applied Sciences Upper Austria
Wels Campus

OAGM/AAPR community - Austrian Association for Pattern Recognition
ARW community - Austrian Robotics Workshop

www.fh-ooe.at/oagm-arw2016

OAGM
OESTERREICHISCHE COMPUTER GESELLSCHAFT
AUSTRIAN COMPUTER SOCIETY
GMAR
scch software competence center hagenberg
fh oö
UNIVERSITY OF APPLIED SCIENCES UPPER AUSTRIA



Welcome

The OAGM and ARW Joint Workshop on Computer Vision and Robotics provides a platform bringing together researchers, students, professionals and practitioners from both research directions to discuss new and emerging technologies in the field of machine driven perception and automated manipulation/autonomous movement. Even though there is a long tradition for OAGM workshops (we are celebrating the 40th workshop since 1980) and the ARW workshops (since 2011), which have their roots in the early days of the Austrian RoboCup workshops (2006), this is the first time that both communities are organizing a joint event. The University of Applied Sciences Upper Austria proudly hosts this workshop - both topics are part of its educational programmes.

The aim of the joint workshop is to discuss latest academic and industrial approaches and to demonstrate the recent progress. The call for papers resulted in 28 full paper submissions and additional 9 papers submitted to the industrial/featured talk and poster track, where finally according to the reviews of an international programme committee 34 contributions (26 talks, 8 posters) have been selected for presentation at the workshop.

To highlight excellent work, the Best Paper Award of 500 EUR sponsored by the Austrian Computer Society (OCG) will be awarded to an outstanding contribution.

The goal of the workshop is also supported by inviting five internationally established researchers, i.e., Oliver Bimber (JKU Linz), Ales Leonardis (BHAM, UK), Laurent Resquet (TIMA, FR), Andreas Mueller (JKU Linz), Andreas Nüchter (JMU, DE), representing both areas.

Kurt Niel (General chair of the workshop)
Peter M. Roth (Chairman OAGM)
Markus Vincze (Chairman ARW)

Wels, 11th May 2016

Programme Overview

Wednesday 11th May 2016 – OAGM

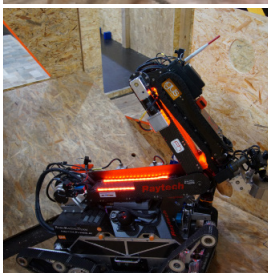
09:00 am	**OAGM Welcome**
09:15 am	**Keynote 1: Oliver Bimber, JKU, Linz AT**
10:15 am	Coffee Break
10:45 am	**WS 1: Learning / Recognition**
12:15 pm	Lunch Break
01:15 pm	**WS 2: Signal & Image Processing / Filters**
02:45 pm	Coffee Break
03:15 pm	**WS 3: Geometry / Sensor Fusion**
04:45 pm	**WS 4: Tracking / Detection**
05:45 pm	**OAGM Meeting**
06:45 pm	Informal Dinner

Thursday 12th May 2016 – OAGM & ARW

08:30 am	**General Official Welcome**
09:00 am	**Keynote 2: Ales Leonardis, Univ. of Birmingham UK**
10:00 am	**Keynote 3: Laurent Fresquet, TIMA, Grenoble FR**
11:00 am	Coffee break
11:30 pm	**WS 5: Vision for Robotics I**
01:15 pm	Lunch break
02:15 pm	**WS 6: Vision for Robotics II**
04:00 pm	**WS 7: Poster OAGM & ARW**
05:00 pm	**ARW Meeting**
06:30 pm	Conference Dinner

Friday 13th May 2016 – ARW

08:45 am	**ARW Welcome**
09:00 am	**Keynote 4: Andreas Müller, JKU, Linz AT**
10:00 am	**Keynote 5: Andreas Nüchter, JMU, Würzburg DE**
11:00 am	Coffee break
11:30 am	**WS 8: Task Planning**
01:00 pm	Lunch break
02:00 pm	**WS 9: Robotic Arm**
03:30 pm	**Close Joint Workshop**
04:00 pm	**RAS Meeting**



Wednesday 11th May 2016

08:00 am – 04:00 pm Registration & Info Desk **Room: Foyer**

09:00 am – 09:15 am OAGM Welcome **Room: Aula**

>> **Kurt Niel** (General Chair)
>> **Peter M. Roth** (OAGM)

09:15 am Keynote 1

Chair: Wilhelm Burger **Room: Aula**

>> **Towards a Flexible, Scalable and Transparent Thin-Film Camera**
Oliver Bimber, JKU Linz AT

10:15 am – 10:45 am Coffee Break

10:45 am WS 1: Learning / Recognition

Chair: Wilhelm Burger **Room: Aula**

>> **One-Shot Learning of Scene Categories via Feature Trajectory Transfer**
Roland Kwitt, Sebastian Hegenbart, Marc Niethammer
>> **Semantic Labeling Enhanced by a Spatial Context Prior**
Daniel Steininger, Csaba Beleznai
>> **Tattoo Detection for Soft Biometric De-Identification Based on Convolutional Neural Networks**
Tomislav Hrkac, Karla Brkic, Zoran Kalafatic

12:15 pm – 01:15 pm Lunch Break

01:15 pm WS 2: Signal & Image Processing / Filters

Chair: Peter M. Roth **Room: Aula**

>> **3-D Shape Recovery of the Left Heart Chamber from Biplane X-Ray Projections Using Anatomical A-Priori Information Learned from CT**
Roland Swoboda, Josef Scharinger, Clemens Steinwender
>> **Robust Blind Deconvolution Using Convolution Spectra of Images**
Philipp Moser, Martin Welk
>> **Directional Wavelet Based Features for Colonic Polyp Classification**
Georg Wimmer, Michael Häfner, Shigeto Joshida, Toru Tamaki, Shinji Tanaka, Jens Tischendorf, Andreas Uhl

02:45 pm – 03:15 pm Coffee Break

03:15 pm WS 3: Geometry / Sensor Fusion

Chair: Bernhard Moser **Room: Aula**

>> **Graph-Laplacian Minimisation for Surface Smoothing in 3D Finite Element Tetrahedral Meshes**
Richard Martin Huber, Martin Holler, Kristian Bredies

>> **Depth Estimation Using Light Fields and Photometric Stereo with a Multi-line-scan Framework**
Doris Antensteiner, Svorad Štolc, Reinhold Huber-Mörk

>> **Guided Sparse Camera Pose Estimation**
Fabian Schenk, Ludwig Mohr, Matthias Rüther, Fritz Fraundorfer, Horst Bischof

04:45 pm WS 4: Tracking / Detection

Chair: Bernhard Moser **Room: Aula**

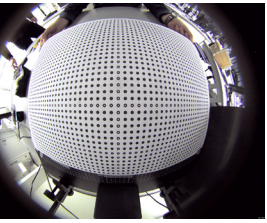
>> **DeVisOR - Detection and Visualization of Unexploded Ordnance Risks**
Sebastian Zambanini, Fabian Hollaus, Robert Sablatnig

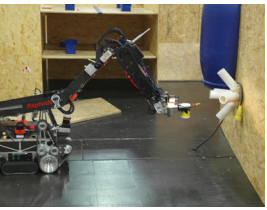
>> **Subpixel Localisation of Nanoparticles in Image Sequences**
Thomas Hoch, Matthias Dorfer, Clemens Helmbrecht

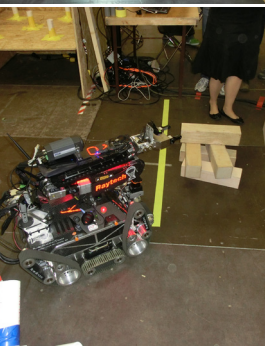
>> **Explaining Point Cloud Segments in Terms of Object Models**
Manuel Lang, Justus Piater

05:45 pm OAGM Meeting **Room: HS 110**

07:00 pm Informal Dinner







Thursday 12th May 2016

08:00 am – 04:00 pm Registration & Info Desk **Room: Foyer**

08:30 am – 09:00 am General Official Welcome **Room: Aula**

>> **Kurt Niel** (General Chair)
>> **Burkhard Stadlmann** (Vice-Dean)
>> **Witold Jacak** (Head of Academic Board)
>> **Alexander Pogany** (BMVIT)

09:00 am Keynote 2

Chair: Bernhard Moser **Room: Aula**

>> **Hierarchical Compositional Representations of Structure for Computer Vision and Robotics**
Ales Leonardis, Univ. of Birmingham UK

10:00 am Keynote 3

Chair: Bernhard Moser **Room: Aula**

>> **Event-based Design for Mitigating Energy in Electronic Systems**
Laurent Fresquet, TIMA Grenoble FR

11:00 am – 11:30 am Coffee Break

11:30 am WS 5: Vision for Robotics I

Chair: Markus Vincze **Room: Aula**

>> **Real-time Tracking of Multiple Rigid Objects Using Depth Data**
Sharath Chandra Akkaladevi, Martin Ankerl, Gerald Fritz, Andreas Pichler

>> **On a Fast Implementation of a 2D-Variant of Weyl's Discrepancy Measure**
Christian Motz, Bernhard Moser

>> **The 3D-PITOTI Project with a Focus on Multi-Scale 3D Reconstruction Using Autonomous UAVs**
Christian Mostegel, Georg Poier, Christian Reinbacher, Manuel Hofer, Friedrich Fraundorfer, Horst Bischof, Thomas Höll, Gert Holler, Axel Pinz

>> **Towards Agricultural Robotics for Organic Farming**
Georg Halmetschlager, Johann Prankl, Markus Vincze

01:15 pm – 02:15 pm Lunch Break

02:15 pm WS 6: Vision for Robotics II

Chair: Kurt Niel **Room: Aula**

>> **A Step Forward in Human-Robot Collaboration - The Project CollRob**
Rosemarie Velik, Bernhard Dieber, David Kirschner, Saeed Yahyanejad, Michael Hofbaur

>> **Industrial Grasping - An Autonomous Order Picking System**
Julia Nitsch, Gerald Steinbauer

>> **User-centered Assistive Robotics for Production - The AssistMe Project Gerhard**
Gerhard Ebenhofer, Markus Ikeda, Andreas Huber, Astrid Weiss

>> **Experiences with RGB-D Based Navigation in Real Home Robotic Trials**
Paloma de la Puente, Markus Vincze

04:00 pm WS 7: Poster OAGM & ARW

Chair: Markus Vincze **Room: Aula**

P-01 **Localization of an Automated Guided Vehicle (AGV) by Stereo Based Visual Odometry and Artificial Landmark Detection**
Daniel Klingersberger, Gerald Zauner,

P-02 **A Holonomic Robot for Rescue Applications**
Raimund Edlinger, Michael Zauner, Walter Rokitansky

P-03 **Low Cost Remote Control for SAR Applications**
Armin Pointinger, Bernd Fuchs, Michael Zauner, Raimund Edlinger, Walter Rokitansky

P-04 **New Algorithm to Speed up the Computation of a Visibility Graph**
Michael Zauner, Raimund Edlinger, Walter Rokitansky

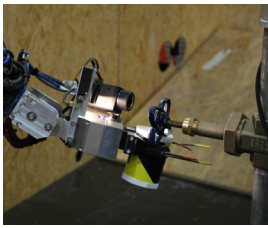
P-05 **Feature Point Extraction with Non-Maximum Suppression on Irregular Grids**
Richard Schönpflug, Hubert Mara

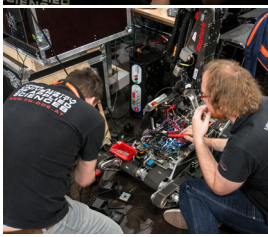
P-06 **On-the-Fly Detection of Regions of Interest to Find Dynamic Objects in Indoor Environments**
Edith Langer, Michael Zillich, Markus Vincze

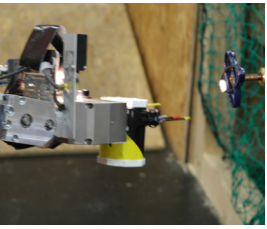
P-07 **Noise Robustness of Irregular LBP Pyramids**
Christoph Körner, Ines Janusch, Martin Cerman, Walter G. Kropatsch

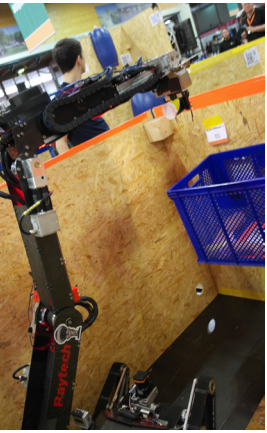
05:00 pm ARW Meeting **Room: HS 110**

06:15 pm Bus Shuttle (from Wels Campus to Moar in Grünbach)
06:30 pm **Conference Dinner** Moar in Grünbach









Friday 13th May 2016

08:00 am – 04:00 pm Registration & Info Desk **Room: Foyer**

08:45 am – 09:00 am ARW Welcome **Room: Aula**

>> **Kurt Niel** (General Chair)
>> **Markus Vincze** (ARW)

09:00 am Keynote 4

Chair: Burkhard Stadlmann **Room: Aula**

>> **Model-Based Control of Industrial Robots - From Theory to Practice**
Andreas Müller, JKU Linz AT

10:00 am Keynote 5

Chair: Burkhard Stadlmann **Room: Aula**

>> **SLAM Goes Industry 4.0 - Mobile Laser Scanning for Flexible Production**
Andreas Nüchter, JMU Würzburg DE

11:00 am – 11:30 am Coffee Break

11:30 am WS 8: Task Planning

Chair: Michael Zauner **Room: Aula**

>> **Controlling and Tracking a Unmanned Ground Vehicle with Ackermanndrive**
Eugen Kaltenegger, Benjamin Binder, Markus Bader
>> **Trajectory Planning Based on Activity Recognition and Identification of Low-level process Deviations**
Sriniwas Chowdhary Maddukuri, Gerald Fritz,
Sharath Chandra Akkaladevi, Matthias Plasch, Andreas Pichler

01:00 pm – 02:00 pm Lunch Break

02:00 pm WS 9: Robotic Arm

Chair: Michael Zauner

Room: Aula

>> **Design, Modeling and Control of an Experimental Redundantly Actuated Parallel Platform**
Kyrill Krajoski, Andreas Müller, Hubert Gattringer, Matthias Jörgl

>> **Energy Optimal Manipulation of an Industrial Robot**
Thomas Lauss, Peter Leitener, Stefan Oberpeilsteiner, Wolfgang Steiner

>> **Design of an Industrial Robot with Six Degrees of Freedom**
René Schweidler, Mohamed Aburaia, Corinna Engelhardt-Nowitzki

03:30 pm Close Joint Workshop

Room: Aula

04:00 pm RAS Meeting

Room: HS 110

WORKSHOP DINNER

Thursday 12th May 2016

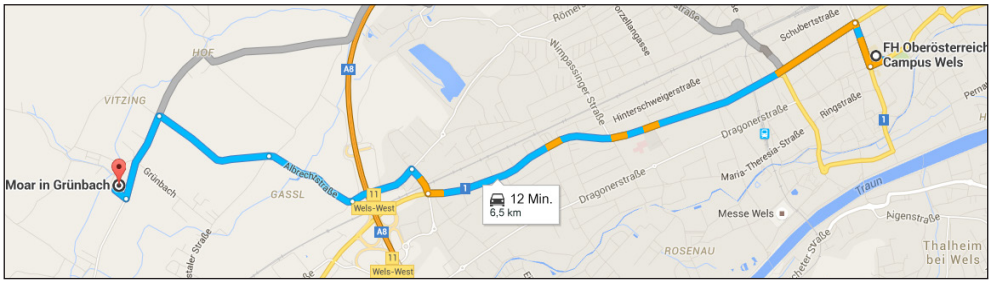
The University of Applied Sciences Upper Austria invites you to have a Workshop Dinner at a traditional Austrian farm house **„Moar in Grünbach“** allowing you to dive into Austrian countryside atmosphere even though beeing only a 15 min car drive away from the the city of Wels.

Registration:

It was necessary to register online for the **Dinner** and the **Bus Shuttle.** If you have registered but cannot participate or you have not registered but would like to participate at the dinner using the bus shuttle service please let us know at the Registration & Info Desk.

Address:

Grünbach 13, A-4623 Gunskirchen (www.moar-in-gruenbach.at)
Distance: 6 km from workshop venue



PUBLIC TRANSPORTATION & PARKING

Parking

Underground parking of FH Upper Austria Wels Campus is possible but limited. For the Wels Campus underground parking there are free parking-exit-tickets available at the registration desk.
Further parking is available in the Traunparkgarage or at underground parking Kaiser-Josef-Platz. (see back-side)

Public Bus

Wels has a tight bus route network. Intersection of all bus routes is the traffic island at the Kaiser-Joseph-Platz. For more information on bus schedules see www.liniewels.at/de/stadtlinien and +43 (0)7242 / 44 212.

Cabs

>> City Taxi Wels: +43 (0)7242 / 911 811
>> Taxi 1718: +43 (0)7242 / 1718
>> Hailed shared taxi: +43 (0)7242 / 20 69 69

USEFULL INFORMATION

Pharmacies in Wels

STERNapotheke: www.sternapotheke.at
>> Bahnhofstraße 11 | Phone: +43 (0)7242 46711
>> Open: Mon-Fri: 8:30 am to 06:00 pm, Sat 8:30 am to 12:30

Einhorn-Apotheke: www.einhorn-apotheke.at
>> Plobergerstraße 7 | Phone: +43 (0)7242 464880
>> Open: Mon-Fri 8:30 am to 06:00 pm, Sat 8:30 am to 12:00

Emergency Numbers

>> European Emergency Number	112
>> Austrian Police Department	133
>> Austrian Ambulance	144
>> Austrian Fire Department	122

Store Opening Hours

The opening hours of shops vary in Austria. Mostly though, the opening hours during the week are
Monday – Friday, from 09:00 am - 06:00 pm and on
Saturday, stores are open until 01:00 pm or 05:00 pm.

ABSTRACTS

Keynote 1 Wednesday, 11th May 2016, 09:15 am

Towards a Flexible, Scalable, and Transparent Thin-Film Camera

Oliver Bimber, JKU Linz Austria

This talk summarizes our progress towards a fully transparent, flexible, and scaelable thin-film image sensor. In contrast to conventional image sensors, it does not capture pixels in image space on the sensor surface, but makes integral measurements in Radon space along the sensor‘s edges. Image reconstruction is achieved by inverse Radon transform. By stacking multiple layers, it enables a variety of information, such as color, dynamic range, spatial resolution, and defocus, to be sampled simultaneously. Multi-focal imaging allows reconstructing an entire focal stack after only one recording. The focal stack can then be applied to estimate depth from defocus. Measuring and classifying directly in Radon space yields robust and high classification rates. Dimensionality reduction results in task-optimized classification sensors that record a minimal number of samples. This enables simple devices with low power consumption and fast read-out times. Combining our sensing approach with lensless coded aperture imaging has the potential to enable entire thin-film camera systems that make the capturing of images, light fields, and depth information possible.

WS 1: Learning / Recognition Wednesday, 11th May 2016, 10:45 am

One-Shot Learning of Scene Categories via Feature Trajectory Transfer

Roland Kwitt[1], Sebastian Hegenbart[1], Marc Niethammer[2]

[1]University of Salzburg, Austria; [2]University of North Carolina, Chapel Hill, NC, USA

The appearance of (outdoor) scenes changes considerably with the strength of certain transient attributes, such as ``rainy“, ``dark“ or ``sunny“. Obviously, this also affects the representation of an image in feature space, e.g., as activations at a certain CNN layer, and consequently impacts scene recognition performance. In this work, we investigate the variability in these transient attributes as a rich source of information for studying how image representations change as a function of attribute strength. In particular, we leverage a recently introduced dataset with fine-grain annotations to estimate feature trajectories for a collection of transient attributes and then show how these trajectories can be transferred to new image representations. This enables us to synthesize new data along the transferred trajectories with respect to the dimensions of the space spanned by the transient attributes. Applicability of this concept is demonstrated on the problem of one-shot scene recognition. We show that data synthesized via feature trajectory transfer considerably boosts recognition performance, (1) with respect to baselines and (2) in combination with state-of-the-art approaches in one-shot learning.

Semantic Labeling Enhanced by a Spatial Context Prior

Daniel Steininger, Csaba Beleznai
Austrian Institute of Technology, Austria

Our observed visual world exhibits a structure. Structure implies that scene objects and their surroundings are not randomly arranged relative to each other, but typically appear in a spatially correlated manner. This underlying structural correlation can render the visual recognition task predictable to a certain extent. Modeling relations between categories is however non-trivial, since categories are often represented at different granularities across distinct datasets. In this paper we present a way to merge fine-level semantic descriptions into basic semantic classes enabling the Generation of spatial contextual priors from a wide range of datasets. The simple contextual model is derived with the objective of employing the learned contextual prior to enhance visual recognition in the form of improved semantic labeling. The prior is captured in an explicit manner by computing occurrence and co-occurrence probabilities of specific semantic classes and class pairs from a diverse set of annotated datasets. We show improved semantic labeling accuracy by incorporating the contextual priors into the label inference process. Results are evaluated and discussed for a common public dataset.

Tattoo Detection for Soft Biometric De-Identification Based on Convolutional Neural Networks

Tomislav Hrkac, Karla Brkic, Zoran Kalafatic
University of Zagreb, Croatia

Nowadays, video surveillance is ubiquitous, posing a potential privacy risk to law-abiding individuals. Consequently, there is an increased interest in developing methods for de-identification, i.e. removing personally identifying features from publicly available or stored data. While most of related work focuses on de-identifying hard biometric identifiers such as faces, we address the problem of de-identification of soft biometric identifiers – tattoos. We propose a method for tattoo detection in unconstrained images, intended to serve as a first step for soft biometric de-identification. The method, based on a deep convolutional neural network, discriminates between tattoo and non-Tattoo image patches, and it can be used to produce a mask of tattoo candidate regions. We contribute a dataset of manually labeled tattoos. Experimental evaluation on the contributed dataset indicates competitive performance of our method and proves its usefulness in a de-identification scenario.

WS 2: Signal & Image Processing / Filters

Wednesday, 11th May 2016, 01:15pm

3-D Shape Recovery of the Left Heart Chamber from Biplane X-Ray Projections Using Anatomical A-Priori Information Learned from CT

Roland Swoboda[1,2], Josef Scharinger[2], Clemens Steinwender[3]
[1]University of Applied Sciences Upper Austria, Austria; [2]Johannes Kepler University Linz, Austria; [3]General Hospital Linz, Austria

Recovering the 3-D shape of the left heart chamber from bi-planar x-ray angiograms is a very

challenging task. The inherently sparse and noisy data available for reconstruction and the ill-posed nature of the inverse problem necessitate the incorporation of a-priori information. To this end, a statistical shape model of the left ventricular (LV) anatomy is learned from high-resolution multislice CT data. Reconstruction is based on a non-rigid 2-D/3-D registration technique. To fit pose and shape of the model to the x-ray images of the patient, simulated projections of the model are calculated and the difference between given and simulated projections is minimized. The presented approach is evaluated using simulated and in-vivo angiograms. For patients where both CT and angiograms are available, the reconstructed LV is compared to the true shape known from CT. The defined similarity metrics used for evaluation show a good correspondence between recovered and true shapes.

Robust Blind Deconvolution Using Convolution Spectra of Images

Philipp Moser, Martin Welk

UMIT Hall/Tyrol, Austria

We present a method for blind image deconvolution that acts by alternating optimisation of image and point-spread function. The approach modifies a variational model recently published by Liu et al. which combines a quadratic data term with a total variation regulariser for the image and a regulariser for the point-spread function that is constructed from convolution eigenvalues and eigenvectors of the blurred input image. We replace the image estimation component with a robust modification of Richardson-Lucy deconvolution, and introduce a robust data term into the point-spread function estimation. We present experiments on images with synthetic and real-world blur that indicate that the modified method has advantages in the reconstruction of fine image details.

Directional Wavelet Based Features for Colonic Polyp Classification

Georg Wimmer[1], Michael Häfner[3], Shigeto Joshida[4], Toru Tamaki[5], Shinji Tanaka[4], Jens Tischendorf[2], Andreas Uhl[1]

[1]University of Salzburg, Austria; [2]RWTH Aachen University Hospital; [3]St. Elisabeth Hospital; [4]Hiroshima University Hospital; [5]Hiroshima University

In this work, various wavelet based methods like the discrete wavelet transform, the dual-tree complex wavelet transform, the Gabor wavelet transform, curvelets, contourlets and shearlets are applied for the automated classification of colonic polyps. The methods are tested on 8 HD-endoscopic image databases, where each database is acquired using different imaging modalities (Pentax's i-Scan technology combined with or without staining the mucosa), 2 NBI high-magnification databases and one database with chromoscopy high-magnification images.

To evaluate the suitability of the wavelet based methods with respect to the classification of colonic polyps, the classification performances of 3 wavelet transforms and the more recent curvelets, contourlets and shearlets are compared using a common framework.

Wavelet transforms were already often and successfully applied to the classification of colonic polyps, whereas curvelets, contourlets and shearlets have not been used for this purpose so far.

We apply different feature extraction techniques to extract the information of the subbands of the wavelet based methods. Most of the in total 20 approaches were already published in different texture classification contexts. Thus, the aim is also to assess and compare their classification performance using a common framework.

Three of the 20 approaches are original. These three approaches extract Weibull features from the

subbands of curvelets, contourlets and shearlets. Additionally, 5 state-of-the-art non wavelet based methods are applied to our databases so that we can compare their results with those of the wavelet based methods.
It turned out that extracting Weibull distribution parameters from the subband coefficients generally leads to high classification results, especially for the dual-tree complex wavelet transform, the Gabor wavelet transform and the Shearlet transform. These three wavelet based transforms in combination with Weibull features even outperform the state-of-the-art methods on most of the databases.
We will also show that the Weibull distribution is better suited to model the subband coefficient distribution than other commonly used probability distributions like the Gaussian distribution and the generalized Gaussian distribution.

WS 3: Geometry / Sensor Fusion **Wednesday, 11th May 2016, 03:15pm**

Graph-Laplacian Minimisation for Surface Smoothing in 3D Finite Element Tetrahedral Meshes

Richard Martin Huber, Martin Holler, Kristian Bredies
Institute of Mathematics and Scientific Computing, University of Graz, Austria

We propose a new method to improve surface regularity of 3D tetrahedral meshes associated with finite element simulations of the heart. Our approach is to minimise the graph Laplacian subject to suitable point constraints. These constraints are computed from the whole Triangulation and prevent a worsening of mesh quality that would otherwise be caused by the smoothing. The resulting minimisation problem is solved via a primal-dual algorithm, leading to a method that globally updates vertex coordinates in each iteration. Experiments confirm that our method reduces surface oscillations of the mesh while preventing degeneration of the triangulation as indicated by mesh quality metrics.

Depth Estimation Using Light Fields and Photometric Stereo with a Multi-line-scan Framework

Doris Antensteiner, Svorad Štolc, Reinhold Huber-Mörk
Austrian Institute of Technology, Austria

In this paper we deal with a combination of two state-of-the-art computational imaging approaches - (i) light fields and (ii) photometric stereo - in order to improve the quality of 3D reconstructions within a multi-line-scan framework. Computational imaging uses a redundant description of an image scene to reveal information which would not have been available via conventional imaging techniques.
In the case of light fields the redundancy is achieved by observing the scene from many different angles, which allows capturing 3D shapes in areas with a prominent surface structure using stereo Vision techniques. Contrarily, photometry makes use of multiple illuminations in order to capture local surface deviations without the necessity of any surface structure. As photometric surface reconstruction is very sensitive to fine surface details and light fields excel in capturing global shapes, naturally a more complete description can be achieved through a combination of both techniques. We present a compact hybrid photometric light field Setup with relatively low costs and improved accuracy, which is therefore well suited for industrial inspection. A multi-line-scan camera is statically coupled with an illumination source to obtain light field data which is also comprised of photometric informati-

on. Novel algorithms have been developed to use this data for an improved 3D reconstruction, which exhibits large-scale accuracy as well as sensitivity to fine surface details.

Guided Sparse Camera Pose Estimation

Fabian Schenk, Ludwig Mohr, Matthias Rüther, Friedrich Fraundorfer, Horst Bischof
Graz University of Technology, Austria

In this paper, we present an idea for a sparse approach to calculate camera poses from RGB images and laser distance measurements to perform subsequent facade reconstruction. The core idea is to guide the image recording process by choosing distinctive features with the laser range finder, e.g. building or window corners. From these distinctive features, we can establish correspondences between views to compute metrically accurate camera poses from just a few precise measurements. In our experiments, we achieve reasonable results in building facade reconstruction with only a fraction of features compared to standard structure from motion.

WS 4: Tracking / Detection **Wednesday, 11th May 2016, 04:45 pm**

DeVisOR - Detection and Visualization of Unexploded Ordnance Risks

Sebastian Zambanini, Fabian Hollaus, Robert Sablatnig
Computer Vision Lab

In this talk, a project named ‚Detection and Visualization of Unexploded Orndance Risks‘ (DeVisOR) is introduced. The project is devoted to the analysis of historical aerial images. These images are currently investigated by employees of a company in order to detect UneXploded Ordnances (UXO). The DeVisOR project aims at developing tools that support the work of the employees by making use of methods stemming from the fields of Computer Vision and Visual Analytics. The main Computer Vision tasks can be grouped into two categories: (1) Automated image registration and (2) object detection.

Task (1) is concerned with the registration of historical aerial images onto modern satellite images. The main challenge is stemming from strong image changes caused by time spans of around 70 years hindering the reliable identification of correspondences between the old and new images, especially in non-urban areas. In combination with the generally low image quality of the old aerial photos and the image content variations caused by illumination changes, a straightforward solution based on standard algorithms using keypoint matching and sample-based transformation estimation does not exist.

Task (2) is dedicated to the automated detection of military objects (e.g. bomb craters or trenches) and assignment of prediction probabilities to the objects found. The task is aggravated by the low quality of the images investigated and their high variety. Due to the absence of large amounts of training data, we are planning to implement and evaluate semi-supervised and active learning procedures, which will also make use of techniques stemming from the field of Visual Analytics.

The presentation will contain preliminary results as well as examples to demonstrate the challenges mentioned.

Subpixel Localisation of Nanoparticles in Image Sequences

Thomas Hoch[1], Matthias Dorfer[1], Clemens Helmbrecht[2]

[1]Software Competence Center Hagenberg, Austria; [2]Particle-Metrix GmbH, Germany

The physical and chemical properties such as solubility, rheology and reactivity are strongly influenced by the size of the respective particles. Hence, measuring the size of micro- or even nano-sized particles in dispersions plays a central role in chemical and biomedical industries. Nanoparticle Tracking Analysis (NTA) is an emerging technology for the quantification of particle size, concentration and zeta potential for particles in the size regime of 10 to 1000 nm. With the NTA technique, particles dispersed in liquids are illuminated with an intensive light beam, e.g. from a laser. An image series of the light scattered by the particles is recorded with a sensitive digital camera perpendicular to the illumination beam. From the image series the Brownian motion of the particles is analyzed by first localizing, second tracking of the particles and third computing the Mean Squared Displacement (MSD) along the track of each individual particle. Having the MSD one can estimate the particles diffusion coefficient and apply the Stoke-Einstein relationship to estimate the hydrodynamic size of individual particle. Current NTA systems use background segmentation method to differentiate the particles from background, mostly with fixed threshold approach. Fixed threshold works well for evenly bright particles but poor for samples with variating particle intensity.

We propose a new method for NTA which utilizes a multi-scale Laplacian of a Gaussian (LoG) detector on top of the background-subtraction model to localize the particles. Our approach uses an optimized thresholding method for each blob individually to compute a super-resolution position estimate. We show that our method is able to find more particles in the video with higher precision over the full size-range of tested solutions (20nm-500nm) in comparison to the fixed threshold approach. We further show that the increased efficiency in particle tracking and the higher precision in the localisation of the particle center leads to particle size distributions that are narrower (having less variance) and are thus better suited for the analysis of mixtures of ploy-disperse particle solutions.

Explaining Point Cloud Segments in Terms of Object Models

Manuel Lang, Justus Piater

Institute of Computer Science University of Innsbruck, Austria

Segmenting the signal of a 3D-sensor represents a core problem in computer vision. Describing segments at the object level is a common requirement for higher-level tasks like action recognition. Non-parametric techniques can provide segmentation without prior model information. However, they are also prone to over- and under-segmentation, especially in case of high occluded scenes. In this paper we propose a model-based recycling of a non-parametric segmentation stream. Sixdegrees-of-freedom (6DOF) model poses are generated from segment-based object recognition and pose estimation. The aligned object models are used in order to resolve over- and under-segmentation by following a bottom-up strategy. Segmentation refinement results from contracting and subdividing input segments in accordance to aligned object models. The proposed algorithm is compared to a trivial model-based segmentation approach that neglects the segmentation stream. Both approaches are evaluated on a set of 24 scenes which are divided into four different complexity categories. The complexity of the scenes ranges from simple to advanced, objects are placed in sparse configurations as well as highly occluded compositions.

Keynote 2: Thursday, 12th May 2016, 09:00 am

Hierarchical Compositional Representations of Structure for Computer Vision and Robotics

Ales Leonardis
Univ. of Birmingham UK

Modelling, learning, recognising, and categorising visual entities has been an area of intensive research in the vision and robotics communities for several decades. While successful partial solutions tailored for particular tasks and specific scenarios have appeared in recent years, more general solutions are yet to be developed. Ultimately, the goal is to design and implement proper structures and mechanisms that would enable efficient learning, inference, and, when necessary, augmentation and modifications of the acquired visual knowledge in general scenarios. Recently, it has become increasingly clear that possible solutions should be sought in the framework of hierarchical architectures. Among various design choices related to hierarchies, compositional hierarchies show a great promise in terms of scalability, real-time performance, efficient structured on-line learning, shareability, and knowledge transfer. In this talk I will first present our work on compositional hierarchies related to visual representations of 2D and 3D object shapes for recognition and grasping and then conclude with some ideas towards generalising the proposed approach to other visual entities and modalities.

Keynote 3: Thursday, 12th May 2016, 10:00 am

Event-based Design for Mitigating Energy in Electronic Systems

Laurent Fresquet
TIMA, Grenoble FR

Today, our digital society exchanges data flows that are incredibly large and the future promises us a data explosion due to the communications between our technological equipment, robots, etc. Indeed, we are close to widely open the door of the Internet of Things (IoT). This data orgy will waste a lot of energy and will contribute to a non-ecological approach of our digital life. Indeed, the Internet and the new technologies consume about 10% of the electrical power produced in the world. Considering that we are only at the beginning of the IoT, it is urgent to enhance the energetic performances of the electronic circuits and systems.

The design paradigm based on synchronizing digital circuit communication with a clock is source of useless activity and of complicated design techniques. The digital circuit design based on local synchronizations, also called asynchronous circuits, is a way to mitigate the power consumption in electronics by only activating the circuitry when an event appears. In addition, another way to reduce energy is to rethink the sampling techniques and digital processing chains. Indeed, by using the Shannon theory, we produce more data than necessary. Indeed, useless data produce more computation, more storage, more communications and also more power consumption. If we go beyond the Shannon theory, we can discover new sampling schemes and new processing techniques able to take advantage of event-based design. Drastically reducing the useless data and activity is maybe the Grail of low-power computing.

WS 5: Vision for Robotics I **Thursday, 12th May 2016, 11:30 am**

Real-time Tracking of Multiple Rigid Objects Using Depth Data

Sharath Chandra Akkaladevi[1,2], Martin Ankerl[1], Gerald Fritz[1], Andreas Pichler[1]
[1]Profactor GmbH, Austria; [2]Alpen-Adria-Universität Klagenfurt, Austria

In this paper, a robust, real-time object tracking approach is presented. The approach relies only on depth data to track objects in a dynamic environment and uses random-forest based learning to deal with problems like object occlusion and clutter. We show that the relation between object motion and the corresponding change in its 3D point cloud data can be learned using only 6 random forests. A framework that unites object pose estimation and object pose tracking to efficiently track objects in 3D space is presented. The approach is robust against occlusions in tracking objects and is capable of real-time performance with 1.7ms per frame. The experimental evaluations demonstrate the performance of the approach against robustness, accuracy and speed and compare the approach quantitatively with the state of the art.

On a Fast Implementation of a 2D-Variant of Weyl's Discrepancy Measure

Christian Motz, Bernhard Moser
Software Competence Center Hagenberg GmbH, Austria

Applying the concept of Hermann Weyl's discrepancy as image similarity measure leads to outstanding robustness properties for template matching. However, in comparison with standard measures this approach is computationally more involving. This paper analyzes this measure from the point of view of efficient implementation for embedded vision settings. A fast implementation is proposed based on vectorization of summed area tables, resulting in a speed-up factor 16 compared to a standard integral image based computation.

The 3D-PITOTI Project with a Focus on Multi-Scale 3D Reconstruction using Autonomous UAVs

Christian Mostegel, Georg Poier, Christian Reinbacher, Manuel Hofer, Friedrich Fraundorfer, Horst Bischof, Thomas Höll, Gert Holler, Axel Pinz
Graz University of Technology, Austria

In this talk, we showcase our outcome of the ambitious 3D-PITOTI project, which involves a multidisciplinary team of over 30 scientists from across Europe. The project focuses on the 3D aspect of recording, storing, processing and visualizing prehistoric rock art in the UNESCO World Heritage site in Valcamonica, Italy. The rock art was pecked into open-air rock formations thousands of years ago and has an inherent 3D nature.

After a project overview, we present the results of the Graz University of Technology's contributions in 3D acquisition and processing with a focus on our novel autonomous UAV system. We elaborate the challenges of 3D reconstruction across vastly different scales, from a valley wide reconstruction down to individual peckings on the rock surface. Within this context, we first present a novel 3D scanning device with sub-millimeter accuracy. Aside from correctly scaled 3D information, the scanning device also provides the surface radiometry without the need for artificial shrouding. Additionally, we point out one application for which this highly accurate 3D data has shown to be crucial: The interactive segmentation of the individually pecked figures.

Finally, we present a novel autonomous UAV system for acquiring high-resolution images at a few meters distance. The system optimizes scene coverage, ground resolution and 3D uncertainty, while ensuring that the acquired images are suitable for a specific dense offline 3D reconstruction algorithm. There are three main aspects that set this system apart from others. First, the system operates completely on-site without the need for a prior 3D model of the scene. Second, the system iteratively refines a surface mesh, predicts the fulfillment of requirements and can thus correct for initially wrong geometry estimates and imperfect plan execution. Third, the system uses the already acquired 2D images to predict the chances of a successful reconstruction with a specific offline 3D densification algorithm depending on the observed scene and potential camera constellations. We demonstrate the capabilities of our system in the challenging environment of the prehistoric rock art sites and then register the individual reconstructions of all scales in one consistent coordinate frame.

Towards Agricultural Robotics for Organic Farming

Georg Halmetschlager, Johann Prankl, Markus Vincze
Vision for Robotics Laboratory, ACIN, Vienna University of Technology

In big scale agricultural farming complex machines with advanced technology shape already the daily routine. In opposite, the field of organic farming is still characterized by multiple manual Tasks that include heavy labor. Our vision is that the fields of automation and robotics offer the necessary technology to lift the burden of back-breaking work off the worker's shoulders. Hence, we propose a scalable and modular agricultural robotic concept that advances farming to the next higher technology level. We provide a low-cost and flexible design in order to realize different autonomous applications, specialized for light weight agricultural work. As proof of concept the proposed configuration is integrated and validated as the experimental platform FRANC. All experiments are performed in real-life outdoor scenarios as vegetable fields that are sowed or planted in row structures. Therefore, we utilize a local navigation system based on a self-parameterizing crop row detection, that enables a local, adaptable, and GPS-independent navigation. The tests show that the hardware and software of the designed system is able to handle rough terrain, offers a high maneuverability, and is adaptable to different row-structures.

WS 6: Vision for Robotics II **Thursday, 12 May 2016, 2:15 pm**

A Step Forward in Human-Robot Collaboration - The Project CollRob

Rosemarie Velik, Bernhard Dieber, David Kirschner, Saeed Yahyanejad, Michael Hofbaur
Joanneum Reseach, Austria

Human-robot collaboration is a novel, hot topic in the field of industrial and service robotics with considerable potential. It offers the possibility to combine human cognitive abilities with the strengths of robot technology in terms of precision and performance, thus opening up a wide range of possibilities beyond the traditional application of robots. The Research project "Collaborative Robotics" (CollRob) is an initiative focusing on the conceptualization, research, development, and Evaluation of novel methods and tools for collaborative and cooperative robots. This article aims at giving an overview about this project in terms of its backgrounds, objectives, and the current status of research covering topics

such as machine perception, sensitive redundant kinematic manipulation, dynamic adaptive planning, human-robot interaction and information exchange, human factors, and safety.

Industrial Grasping - An Autonomous Order Picking System

Julia Nitsch, Gerald Steinbauer
Institute for Software Technology, Graz University of Technology, Austria

Automated storing, retrieving, and delivering items is an important part of Industry 4.0 application. For low-volume this task is done usually manual. In this paper we present an architecture and a proof-of-concept implementation for order picking using the robot Baxter from Rethink Robotics. The main contribution besides providing full functioning prototype is a dependable control architecture.

User-centered Assistive Robotics for Production - The AssistMe Project Gerhard

Gerhard Ebenhofer[1], Markus Ikeda[1], Andreas Huber[2], Astrid Weiss[2]
[1]Profactor GmbH; [2]ACIN-Institute of Automation and Control Vienna University of Technology

In this paper we present the first results of the AssistMe project which aims at enabling close humanrobot cooperation in production processes. AssistMe develops and evaluates different means of interaction for programming and using a robot-based assistive system through a multistage usercentered design process. Together with two industrial companies human-Robot cooperation scenarios are evaluated in two entirely different application areas. One field of application is the assembly of automotive combustion engines while the other one treats the machining (polishing) of casting moulds. In this paper we will describe the overall Project methodology, followed by a description of the use cases and a detailed outline of the first robotic prototype set up. The paper closes with an overview on the results of the first user trials that show very similar findings for both use cases and gives an outlook on the next expansion stage of the human-robot cooperation scenario.

Experiences with RGB-D Based Navigation in Real Home Robotic Trials

Paloma de la Puente, Markus Vincze
TU Wien, Austria

Autonomous robot navigation is an important and challenging component that is still missing in many real applications. In particular, home environments present open challenges that differ notably from one user apartment to another. Laser sensors cannot perceive objects at all heights commonly found in homes, we investigated the feasibility and suitability of using RGBD sensors for 2D autonomous navigation and a variety of tasks at real user homes. We use the concept of virtual laser scans to integrate RGBD data into mapping and localization methods. For realistic user interaction in actual homes we designed and improved ,over several pilot studies, the Robot behavior for tasks such as approaching the user. In this paper, we report the adaptations needed to cope with home-specific challenges using RGBD sensors as a solution to perceive 3D environments.

Localization of an Automated Guided Vehicle (AGV) by Stereo Based Visual Odometry and Artificial Landmark Detection

Daniel Klingersberger, Gerald Zauner
University of Applied Sciences Upper Austria, Austria

Localization in a known environment is an essential topic in the field of robotics – consequently a variety of methods (e.g. Visual Odometry or SLAM) are scientifically well established. Compared to experimental robotics, the determination of position based on Machine Vision approaches is not yet fully implemented in the domain of Automated Guided Vehicles (AGV). Thus, the aim of this master's thesis is to design, realize and test a localization system exclusively based on Machine Vision for the use in AGVs.

The x- and y-axis positioning as well as the determination of orientation of the vehicle in all three axes is carried out by a stereo camera based Visual Odometry approach and a supporting detection of artificial landmarks placed on the ceiling. Both methods complement each other perfectly: while Visual Odometry bridges distances without landmarks, drift caused by Visual Odometry is corrected by artificial landmarks.

Test series have shown that the localization error falls below ±20mm if the distance between camera and landmark does not exceed 4500mm. Also the inclination of the vehicle is equalized.

This localization system has various advantages compared to well established methods: designing and installation efforts can be reduced, while the flexibility for route changes can be increased compared to traditional magnetic guidance systems. The interference immunity is higher compared to contour matching methods due to the use of absolute reference points placed on the ceiling. The proposed system is not suitable for use in halls because the distance between camera and ceiling-landmarks should not exceed 4500mm. Nevertheless, this localization system is an interesting alternative to well established methods primarily for the use in the public sector, e.g. hospitals or libraries.

A Holonomic Robot for Rescue Applications

Raimund Edlinger, Michael Zauner, Walter Rokitansky
[1]University of Applied Sciences Upper Austria, Austria;

For autonomous mobile robots it is important to have the capability to plan and reach a defined goal. In this poster, we present a novel mobile robot for urban search and rescue, capable of achieving a high level of locomotion. The preliminary aim is to build rescue robots which are able to drive in an unstructured environment and search for victims. Mobile robots have been an essential element in search and rescue scenarios and especially in space exploration to perform science on lunar and planetary objects. With advancements in research and technology many mobile robots have been developed with different configurations, geometries, sizes and flexibility of locomotion. These systems share different performance qualities under certain operational conditions. A new mechanism is developed to drive sideways which could be helpful especially in difficult curved staircase or uneven terrain.

Low Cost Remote Control for SAR Applications

Armin Pointinger, Bernd Fuchs, Michael Zauner, Raimund Edlinger, Walter Rokitansky
[1]University of Applied Sciences Upper Austria, Austria;

This poster presents a low cost remote control for SAR applications. The use of multi robot systems makes it difficult to control all robots from one operator base. The case described herein with a maximum weight of <10 kg is easy to handle and transport and fits the requirements for cabin baggage by airlines. To save space current low-cost embedded systems are used which are very energy efficient and provide a long operation time. In order to build a flexible and modular system, the communication and energy supply are able to work with different sources. The communication between robot and operator base is possible with a LAN cable or via wireless LAN. The energy can be delivered by a battery or an external energy grid. The batteries have enough power to run the operator station for 2 hours and enables rescue operations to be fulfilled under the harshest conditions. Because of the "Spacemouse" and the ergonomic control elements used, the unit is user friendly and can be operated with gloves and in dark environments. The elements are clearly structured and make using the robots more intuitive. The control elements are focused in three groups: the engine, the arm control and special functions. All components and joints are sealed with rubber seals. Therefore, rain or dusts in harsh environment guess no problem for the remote control unit. Experts from first responder organizations will test the control in the coming years and contribute their experience to its further development.

New Algorithm to Speed up the Computation of a Visibility Graph

Michael Zauner, Raimund Edlinger, Walter Rokitansky
University of Applied Sciences Upper Austria, Austria

This poster describes a new algorithm called B# which is needed to find the visibility graph of a polygonal region with obstacles defined by simple polygons. It focuses on finding the entire visibility graph among polygonal obstacles which has been tuned in a variety of test cases. The obstacles are restricted to simple cases, i.e. where no edge intersects any other edges. The visibility graph problem itself has long been studied and has been applied to a variety of areas. A common use for it has been for finding the shortest path. The B# algorithm has been implemented adjustments made and experimental comparisons via time measurements carried out. A comparison between "Naïve algorithm" and "Naïve algorithm with B#" was performed with different numbers of vertices. The B# algorithm by itself doesn't calculate the visibility graph. It selects the next best obstacle where the calculation should proceed.

Ridge Point Extraction with Non-Maximum Suppression on Irregular Grids

Richard Schönpflug, Hubert Mara
IWR – Heidelberg University, Germany

Assyriology is the study of cultures related to cuneiform writing, which was used for more than three millennia before Christ in the ancient Middle East. Drawing hundreds of thousands of documents with cuneiform script manually is a tedious task and leads to a demand for automated tools assisting the daily work of assyriologists. The cuneiform script is a handwriting using wedges (Latin: cunei) imprinted into clay tablets. Therefore the digitization of cuneiform tablets is increasingly using 3Dscanners that provide irregular triangular grids in R3. These grids i.e. meshes are discrete manifolds, which are

first filtered by using Multi-Scale Integral Invariants (MSIIs) for visualization. Secondly the MSII filter results are used to extract points along the or ridges within the 3D-model leading to a digital drawing of e.g. a cuneiform tablet. Therefore we choose the idea of the non-Maximum suppression as used by the Canny edge detector for raster images. In contrast to the Canny edge detector we had to (i) to adapt to an arbitrary number of neighboring vertices, which have to be reduced locally in case of flat areas; (ii) to implement an estimator for the gradient direction, which cannot be provided by the MSII filter; and (iii) to provide a border treatment as real world meshes have missing parts. All the work was embedded within our modular GigaMesh software framework. Results are shown for synthetic and real data, demonstrating a computational complexity of O(n), which requires only one parameter. Finally a summary and an outlook are given.

On-the-Fly Detection of Regions of Interest to Find Dynamic Objects in Indoor Environments

Edith Langer, Michael Zillich, Markus Vincze
TU Wien, Austria

In this paper we present a novel method to identify regions of interest in indoor environments with a mobile robot using an RGB-D sensor. Our approach is based on octomaps which are used for navigation. Regions of interest are regions which have changed and therefore can potentially provide the robot with new information about manipulable objects. In our approach, we can compute those regions on-the-fly by comparing octomaps without the need to explicitly scan the environment for objects. As a result, the robot can request regions of interest any time independently of its current position, whenever it's planning system decides it requires new information. To explore one of the regions our method creates view points for the robot so that it has the region in its field of view. We then run object segmentation on these regions of interest to provide object hypotheses, which can then be fed into further modules like classification or manipulation.

Noise Robustness of Irregular LBP Pyramids

Christoph Körner, Ines Janusch, Martin Cerman, Walter G. Kropatsch
PRIP, TU Wien, Austria

In this paper, we briefly introduce the SCIS algorithm - a hierarchical image segmentation approach based on LBP pyramids - and evaluate its robustness to uniform, Gaussian, and Poisson distributed additive chromatic noise. Moreover, we study the influence of Image properties such as the amount of details and SNR on the segmentation performance. Our Evaluation shows that SCIS is robust to Gaussian and Poisson noise for our testing environment.

Keynote 4: **Friday, 13th May 2016, 09:00 am**

Model-Based Control of Industrial Robots - From Theory to Practice

Andreas Müller, JKU Linz Austria

Industrial robotics has seen a major overhaul in terms of improved designs, novel kinematics, and actuation concepts. Redundancy, for instance, is becoming an important factor for increasing flexibility

and robustness. As such, kinematic redundancy of serial manipulators (mimicking anthropomorphic arms) and actuation redundancy of parallel manipulators are prevailing concepts. Aiming at reducing energy consumption and increasing agility, light-weight robotics is another example of innovation in robotics. While these may not be at the core interest of a majority of robot end users, reducing production and cycle times was and still is an important issue. The solution concept applicable to all these problems is the model-based control. In contrast to classical decentralized control schemes, which are commonly used in industrial robots, model-based control schemes make use of a dynamical model. Standard control systems do not account for such models. This will be vital, however.
In this presentation the basic concept of model-based control will be discussed. Particular attention will be given to efficient formulations of the dynamic model accounting for rigid as well as elastic manipulators. Strategies for the geometric calibration and the identification of dynamic parameters will be presented. It will be shown how these concepts can seamlessly integrated in industrial controller hardware.

Keynote 5: Friday, 13th May 2016, 10:00 am

SLAM goes Industry 4.0 - Mobile Laser Scanning for Flexible Production

Andreas Nüchter, JMU Würzburg Germany

The terrestrial acquisition of 3D point clouds by laser range finders has recently moved to mobile platforms. Mobile laser scanning puts high requirements on the accuracy of the positioning systems and the calibration of the measurement system. We present a novel algorithmic approach to the problem of calibration with the goal of improving the measurement accuracy of mobile laser scanners. We developed a general framework for calibrating mobile sensor platforms that estimates all configuration parameters for any configuration of positioning sensors including odometry. In addition, we present a novel semi-rigid SLAM algorithm that corrects the vehicle position at every point in time along its trajectory, while simultaneously improving the quality and precision of the entire acquired point cloud. Using this algorithm the temporary failure of accurate external positioning systems or the lack thereof can be compensated for. We demonstrate the capabilities of our two newly proposed algorithms on a wide variety of data sets.
Applications for the developed suite of algorithms range from 3D mapping for autonomous driving to precise digitization of production lines in the automotive context. We end the talk with a description of an innovative start-up in the area of robotic SLAM.

WS 8: Task Planning Friday, 13th May 2016, 11:30 am

Controlling and Tracking an Unmanned Ground Vehicle with Ackermanndrive

Eugen Kaltenegger, Benjamin Binder, Markus Bader
Vienna University of Technology, Austria

This work presents a tracking and control mechanism for an UGV (Unmanned Ground Vehicle) and its integration into ROS (Robot Operating System). The overall goal of which this work is part, is the creation of a fleet of ackermann robots to conduct studies in the field of autonomous driving. In order

to achieve this goal a 1:10 RC-race car model is equipped with an Arduino board to control the vehicles actuators and a Raspberry Pi to host the ROS server. In addition, a physics simulation is used to model this car for testing. The shown results support the used velocity motion model and the applicability of the developed interface to control both platforms.

Trajectory Planning Based on Activity Recognition and Identification of Low-level Process Deviations

Sriniwas Chowdhary Maddukuri, Gerald Fritz, Sharath Chandra Akkaladevi, Matthias Plasch, Andreas Pichler
PROFACTOR GmbH, Austria

Improving work efficiency and ensuring safety of the human worker while the human worker and robot simultaneously perform the tasks in close proximity is one of the key research topics in human-robot cooperation. Given a process which contains a set of tasks or process steps performed within the shared human-robot workspace, a methodology for the robot's trajectory planning will be mentioned in this concept paper. The methodology will be based on activity recognition and identification of low-level process deviations. Here, the low-level process deviations which occur from the robot assistant side are mainly focussed.

WS 9: Robotic Arm **Friday, 13th May 2016, 02:00 pm**

Design, Modeling and Control of an Experimental Redundantly Actuated Parallel Platform

Kyrill Krajoski[1], Andreas Müller[1], Hubert Gattringer[1], Matthias Jörgl[1,2]
[1]Johannes Kepler University Linz, Austria; [2]Trotec GmbH

Actuation redundancy is a means to improve the dexterity, accuracy and reliability of parallel manipulators (PKMs). Over the last decade, various novel designs and control concepts have been developed and implemented in functional prototypes. In spite this extensive Research several fundamental issues still remain to be addressed. This requires test benches allowing for flexible and modular setup of PKM prototypes. Aiming at agile light-weight PKMs, such a test bed should in particular enable to replace rigid by elastic links, and to implement model-based robust control concepts.
Such an experimental test platform is presented in this paper. The PKM under investigation is a 2-DOF planar PKM redundantly actuated by three actuators. Ist mechanical design and actuation concepts together with the control system are presented. The dynamical model is presented as Basis for the non-linear control. Fully parallel manipulators are characterized by repetitive use of identical modules connecting the moving and fixed platform. Therefore emphasize is given to the submodel- ing concept, which allows seamless integration of different modules (rigid vs. flexible links). Initial results are reported for the 2-PKM when controlled by an augmented PD scheme.

Energy Optimal Manipulation of an Industrial Robot

Thomas Lauss, Peter Leitener, Stefan Oberpeilsteiner, Wolfgang Steiner
University of Applied Sciences Upper Austria, Austria

The main goal of this contribution is to determine the excitation of an industrial robot, such that the energy consumption becomes a minimum during the manipulation of the tool center point (TCP) from a

start position to a given end point within a predefined time. Such Tasks can be restated as optimization problems where the functional to be minimized consists of the endpoint error and a measure for the energy. The gradient of this functional can be calculated by solving a linear differential equation, called the adjoint system. On the one hand the minimum of the cost functional can be achieved by the method of steepest descent where a proper step size has to be found or on the other hand by a Quasi-Newton algorithm where the Hessian can be appreciated. The theory is applied to a six-axis robot and the identification leads to a reduction of 47% of the Signal energy.

Design of an Industrial Robot with Six Degrees of Freedom for Educational Purposes

René Schweidler, Mohamed Aburaia, Corinna Engelhardt-Nowitzki
UAS Technikum Wien, Austria

In state of the art production and assembly lines industrial robots with six axes are widely used to manipulate production goods in all six degrees of freedom in space. Hence, mechatronics and robotics students have to achieve an in-depth comprehension regarding the configuration and adaptation of industrial robots from different manufacturers for applications such as welding, milling, assembling or the handling of components. However, these industrial robots typically cannot be disassembled to explore their internal structure and functionality due to, e.g., warranty reasons. Thus, educational facilities have to use auxiliary means, such as simulation in respective teaching units. To solve that problem, this paper describes the dimensioning and design of an industrial robot with six degrees of freedom for educational purposes, produced by the use of additive manufacturing techniques. Its main strengths are its low costs despite full functionality, its sound maintainability, and the fact that it can be disassembled multiple times by students in the course of, e.g., mechanics, electronics or software development projects. Besides, the proposed educational robot platform has been designed safe-to-use and aesthetically pleasing. Further mechanical structure optimization, the synthesis of the mathematical and kinematic model and control system configuration have to be done in future projects.

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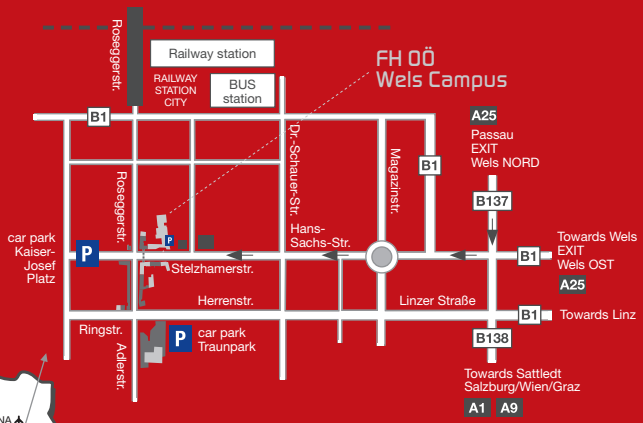

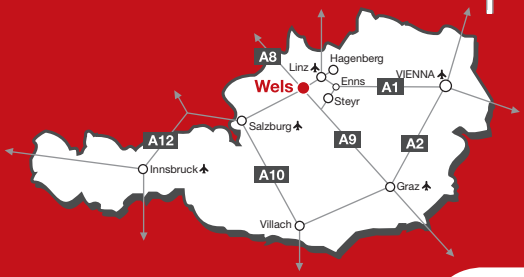

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