DiplDiss Seminar Winter Term 2019
Walter G. Kropatsch

November 12th, 2019

1 Program:

13:00 - 13:05	***Opening (Walter G. Kropatsch)***
	Representation and analytical methods (for animals)
13:05 - 13:15	Topology-based Shape Descriptors: LBP scale-space, Distance Profiles and Future Aims (Ines Janusch, PhD)
13:15 - 13:25	3D Feature Recognition - Recognition of Design Features via a Hybrid Graph Learning System (Christian Brändle – MSc)
13:25 - 13:35	Analyzing the courtship dance of the golden-collared manakin's from Videos (Anna Gostler – MSc)
	Graph pyramids
13:35 – 13:45	Combinatorial Pyramid - Software (Darshan Batavia - PhD)
13:45 – 13:55	Learning of Distortion in camera calibration by the Graph Pyramid (Majid Banaeyan - PhD)
13:55 - 14:15	***Break***
	New Technology + students
14:15 - 14:25	Improving Image Segmentation for under-segmented images using Distance Transform (Antonello Scaldaferri MSc)
14:25 – 14:35	PHd topics proposal (Mostafa Rouzbahani PHd)
14:35 - 14:55	Finding low quality segmented OCT scans with feature extraction and curve fitting (Verena Renner BSc)
14:55 – 15:00	***Closing (Walter G. Kropatsch)***

2 Detailed program:

Representation and analytical methods (for animals):

Topology-based Shape Descriptors: LBP scale-space, Distance Profiles and Future Aims (Ines Janusch, PHd)

As small perturbations in a shape's boundary (noise or changes of minor shape details) may alter the topology of its graph representation, the LBP scale-space - a robust shape descriptor that is based on the persistence of LBP classes over a range of radii centred at critical points of the shape's skeleton was introduced. The descriptor not only allows for the representation and comparison but also for the reconstruction of the shape. This representation revolves around the critical point at its centre. In contrast, measuring the Euclidean distance of each boundary pixel to the nearest pixel of the shape's medial axis and the geodesic distance along the shape's medial axis to a reference point yields the geodesic distance profile - a boundary-based topological shape descriptor. The geodesic distance profile is invariant against translation, rotation and scaling as well as against articulations and deformations.

3D Feature Recognition - Recognition of Design Features via a Hybrid Graph Learning System (Christian Brändle, MSc)

The main goal of this research is to recover the design intent of a CAD/CAM-constructor via detection of design features on a boundary representation model.
The detected 3D geometric features are used to conclude design features that are machined by corresponding machining features that are common in CAM production processes.
The tracked design features are combined to reverse the production process from a machined stock to a not machined bulk.
There are different levels of abstraction for features. Starting from geometric features detectable from the boundary representation model, design features can be concluded which represent the design intent of the designer in a CAD system resulting in machining features that provide the basis for a CNC machine to machine a certain machining volume with a certain strategy in a CAM system.
So a geometric feature is based on bare geometry recognition, a design feature represents the logical design intention of a constructor in a CAD environment, and a machining feature can be processed by a CNC-machine.
A design feature always have central parametric elements which describe essential parts of its nature. The main goal is to recover the design intent of the model designer to enable a reparametrization of a parametric design feature to adapt or change those design intents.

Analyzing the Courtship Dance of the Golden-Collared Manakin from Videos (Anna Gostler - MSc)

I will present my completed master thesis on analyzing videos of the golden-collared manakin (Manacus vitellinus). The golden-collared manakin is a tropical bird species, in which the male performs an acrobatic displays to court mates. To be able to compare diff erent courtship displays and better understand the courtship dance, biologists recorded the birds in the wild with high-speed cameras. To analyze the courtship dance the birds need to be first tracked, so that the behavior can be classified, and finally visualized. Manually labeling every frame in hours of video material is a time-consuming process. Automatic tracking and behavior recognition enables faster analysis of videos, which would save human annotators months of work. In this thesis, we present a thorough state-of-the-art review and highlight the challenges of the manakin videos. The manakin videos present several challenges for visual tracking and behavior recognition. The bird's rapid and abrupt movement causes strong motion blur and is hard to predict. The bird's appearance changes strongly. Additionally, background clutter visually resembles and occludes the bird. The ManakinTracker is a visual long-term tracker designed to handle the challenges of the manakin videos. The ManakinTracker finds potential bounding boxes with background subtraction, models the bird's appearance with a convolutional neural network and learns a motion model. It is able to detect the bird moving out of the frame and re-detect it. Based on the trajectory obtained through the ManakinTracker, we identify the bird's typical courtship behaviors: perching, jumping, beard-up posture, and wing-snap. The behavior is then visualized by plotting the trajectory and in a sequence plot. We compare our tracker to 11 state-of-the-art trackers in terms of robustness and accuracy and perform an analysis of tracking failures.

Graph pyramids:

Combinatorial Pyramid - Software (Darshan Batavia - PhD)
The software for Combinatorial Pyramid which was previously available used MATLAB and was a sequential process which took around 8-10 hours for an image of size 350 _ 250 (approx.). The new version of software which is approximately 75-80% completed gives the results in few seconds, depending on the size of the image. Moreover, the new version do not yet use GPU for its processing and still has space for improvements and modi_cations.
Apart from software, theoretical research was made to extend the theory of topological properties and monotonic path from 2D surface to 3D volumes. Exploiting the critical and non critical points in 3D in both continuous and discrete domain to get a meaningful relation from a topological point of view. Future work includes completion of software, relation and usage of primal and dual in 3D, use machine learning to segment the image into slope regions.

Learning of distortion in camera calibration by the Graph Pyramid (Majid Banaeyan - MSc)
Usual camera calibration methods assume the geometrical model to map the 3D world to a 2D image coordinate system and to correct distortion. These approaches extract robust key features and employ different metrics to measure the similarity along epipolar lines or curves in order to solve the correspondence problem. Instead, we propose an approach that does not make any assumptions about the projection models of the lens and allows arbitrary distortion. Moreover, solving the correspondence problem is replaced by graph pyramid based segmentation. A cylindrical multicolor checkerboard pattern is used with special color coding to help the calibration process and avoid the ambiguity of origin of checkerboard pattern. In graph based segmentation the homogeneous regions inside the square patches are merged and the contraction kernels along the boundaries are frozen. These frozen contraction kernels then are kept and used to refine homogeneous patches in iterative procedures and learn the lenses distortion. In this study, a specific setup of six outwardlooking cameras is considered which are equipped with very wide fisheye lenses. The proposed method combines the image alignment and distortion correction in image stitching and provide the parallel processing for individual camera in multi-camera systems.

New Technology and Students:

Improving Image Segmentation for under-segmented images using Distance Transform (Antonello Scaldaferri MSc)
The project concerns the improvement of image segmentation for under-segmented images, ie segmented images in which there are merged patches, that is, patches segmented as the same patch.
In the first instance, the type of images taken into account are distorted images, which show checkerboard patterns, but the technique that is being developed is much more general and therefore it can be applied to any type of pattern.
Starting, therefore, from an input segmented image, the distance transform of this segmented image is computed.
Later, the saddle points are sought in this transformed image, which indicate the contact points between two separate patches, ie the point where two distinct patches are merged and segmented like the same patch.
The localization of these points, in the case of images showing chessboard patterns, equates to the detection of the corner points of the pattern.
The first fundamental step is the study of distance transform, to understand which is the best distance metric, which should be used.
Secondly, a methodology for finding saddle points in the transformed image must be defined.
As a last step, these identified saddle points must be used for improving the segmentation, that is, for splitting merged patches in the segmented image in input.
The main study objective is, therefore, to understand what are the advantages of using the distance transform compared to the other methods of existing improvements, to understand what the limits of this technique are, when it fails and when it is successful.

PhD Topics proposal (Mostafa Rouzbahani PHd)
As a new PhD student I will present the topics which I'd like to peruse them during my thesis.
Janusch et al. [1] Shows that changing scale space origins to new ones like LBP can change the results of classification. Furthermore it can decrease the reconstruction errors of a shape. In other hand Fleischer et al. [2] studied the traveling salesman problem with new approach. The vertices of the problem represented in log-polar map. The paper show that in some cases this new representation can lead to better result than Cartesian representation in classification algorithms. Combining these two ideas lead us to new metric based on log-polar maps. The questions will be arise in this way. What happened to the critical and saddle point in this new metric? What will be the cost of change, remove or add in this new metric? Is there any advantage to the other metric?
The next topic will be the applications of graph theory in brain connectivity. During different tasks, different region in the brain will be activated. These activation can be measured by EEG. The EEG is recorded by electrodes which placed on the head. We can assume these electrodes as a vertices of graph and the connectivity among these electrodes can be represented as the edges. This topic is more about neuroscience and application of graph in other science.

Reference

[1] Ines Janusch and Walter G. Kropatsch. LBP Scale Space Origins for Shape Classification. In Walter G. Kropatsch Nicole M. Artner, Ines Janusch, editor, Proceedings of the 22nd Computer Vision Winter Workshop 2017, pages 1–9, Retz, A, February 2017. TU Wien, PRIP Club. ISBN 978-3-200-04969-7.

Finding low quality segmented OCT scans with feature extraction and curve fitting (Verena Renner BSc)

The retina has an average thickness of 0.5 mm. Within these 0.5 mm there are 13 layers, whose thickness is crucial to decide whether a retina needs to be treated or not. Due to the wiedly spread technology and research on optical coherence tomography the amount of scans produced increases rapidly. Letting experts do the segmentation of this vast amount of data by hand would be very time consuming and expensive. The need of automated segmentation algorithms of OCT scans is commonly known and also has come to promising results. But since a precise layer segmentation is nessesary for further decision-making the continuous improvement of segmentation algorithms is desirable. Within this work the first step of improvemnt is taken by finding segmentation errors of a specific algorithm. Firstly there will be a feature extracted of a retinal layer. Secondly there were executed two different methods for approching the problem of the search for low qualitiy segmentation. Within the first method a mean and standard deviation feature comparision was tried and within the second a curve fitting and coefficient comparison was calculated. Both methods lead to the result that the exclusion of the selected scans increases the mean Dice similarity coefficient of the segmentations of the first and underneath layers. Lastly some possible extentions of this work are presented.