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ISPA 2017: 10th International Symposium on Image and Signal Processing and Analysis, Book of Abstracts

Edited by Vitomir Štruc and Janez Perš

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ISPA 2017

10th International Symposium on Image and Signal Processing and Analysis

Book of abstracts

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Welcome

It is our privilege to welcome you to the 10th International Symposium on Image and Signal Processing and Analysis (ISPA 2017). The 2017 edition of the symposium was organized by the Faculty of Electrical Engineering of the University of Ljubljana and was held in Ljubljana, Slovenia, from September 18th to 20th. ISPA continues to be a reputable forum for presenting new ideas and achievements in the field of image and signal processing. The meeting builds on the success of previous iterations of ISPA and strives to present the most novel and highest-quality work emerging from a rigorous review process.

ISPA 2017 was technically co-sponsored and supported by the IEEE Signal Processing Society, the IEEE Slovenia Section, the IEEE Slovenia Section Signal Processing Chapter and the Slovenian Pattern Recognition Society, a branch of IAPR.

Professors Stanislav Kovačič and Sven Lončarič served as the general Co-Chairs for the symposium and overlooked all organizational activities, while Associate Professors Vitomir Štruc and Matej Kristan together with Professor Mladen Vučić served as the Program Co-Chairs for the meeting. Local arrangements were handled by Assistant Professor Janez Perš. Professors Sanjit K. Mitra and Ruzena Bajcsy served as the Honorary Chairs of the symposium.

This year's meeting received 66 submissions, all of them subjected to the peer-review. The paper selection procedure was coordinated by the Program Co-Chairs and comprised a rigorous single-blind reviewing process. The Program Co-Chairs assembled an international Technical Program Committee consisting of 109 renowned experts from various fields, including computer vision, image and signal processing and machine learning, that conducted the review. Each submission was carefully examined by at least two experts who were asked to comment on the strengths and weaknesses of the papers and justify their recommendation for accepting or rejecting a submission. The Program Co-Chairs used the reviewer's comments and suggestions to render the final decision on each paper. To ensure fair treatment of all submissions, papers co-authored by one of the Program Co-Chairs were handled by a non-conflicting chair. From 66 submissions, 44 papers were accepted for presentation at ISPA 2017, resulting in an acceptance rate of 66.7 %. From 44 accepted papers, 18 were accepted for oral presentation, yielding an oral-acceptance-rate of 27.3 %. The paper selection process was very competitive and several good papers could not be accommodated in the final program. The Program Co-Chairs would like to thank the members of the Technical Program Committee for their time and effort, which helped make ISPA 2017 a success.

Next to the regular conference program, ISPA 2017 also featured a special session on *Endoscopic Imaging and Image Analysis*. The special session was organized by Dr. András Hajdu, Dr. Péter Török and Dr. Balász Harangi and comprised three presentations from experts in the field of endoscopic imaging that complemented the presentations accepted for the main part of the symposium. The Program Co-Chairs appreciate the efforts of the special session organizers and are thankful for their hard work in setting up this session for ISPA 2017.

To acknowledge and promote scientific excellence, the organizers of the symposium awarded the *ISPA 2017 Best Paper Award* to the most outstanding work presented at the meeting. The award was sponsored by the Kolektor Group d.o.o. and we would like to thank our sponsor for the generous support. For the award-selection process the Program Co-Chairs first composed a candidate list of the top 5 papers that received the highest scores and recommendations during the review process. This short list was then given to the ISPA 2017 General Co-Chairs who made the final selection based on the reviewer feedback, novelty and contribution of the submission and the quality of presentation. We would like to congratulate the winners of the Best Paper Award for their achievement. Congratulations!

We hope that the 10th International Symposium on Image and Signal Processing and Analysis (ISPA 2017) was a productive and enjoyable meeting for you and your colleagues and inspired new ideas that capable of advancing your professional activities.

Welcome and thank you for your participation!

Vitomir Štruc, Matej Kristan, Mladen Vučić

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Keynote Talks

Monday, September 18th, 2017, 8:45 – 9:45

Speaker: Prof. Dr. Slobodan Ribarić,
University of Zagreb, Croatia

Title: Face De-identification for Privacy Protection

Dr. Slobodan Ribarić is a Full Professor at the Department of Electronics, Microelectronics, Computer and Intelligent Systems, Faculty of Electrical Engineering and Computing, University of Zagreb, Croatia. S. Ribarić is a head of the Laboratory of Pattern Recognition and Biometric Security Systems (RUBOISS). Slobodan Ribarić received the B.S. degree in electronics, the M.S. degree in automatics, and the PhD. degree in electrical engineering from the Faculty of Electrical Engineering, Ljubljana, Slovenia, in 1974, 1976, and 1982, respectively. His research interests include Pattern Recognition, Artificial Intelligence, Biometrics, Computer Architecture and Robot Vision. He has published more than one hundred and fifty papers on these topics. Ribarić is author of five books and co-author of the book An Introduction to Pattern Recognition. Professor Ribarić has held a series of invited lectures at universities and institutes in China, Germany, Italy, India, Denmark and Slovenia. He is a member of Editorial Board of Journal of Computing and Information Technology (CIT). Ribarić is a member of the IEEE and MIPRO.

Abstract: Privacy is one of the most important social and political issues in our information society, characterized by a growing range of enabling and supporting technologies and services such as communications, multimedia, biometrics, big data, cloud computing, data mining, internet, social networks, and audio-video surveillance. Privacy described as "an integral part of our humanity" and "the beginning of all freedom", has no unique definition; even more, it is a concept in disarray. De-identification is one of the basic methods for protecting privacy. It is defined as the process of removing or concealing personal identifiable information, or replacing them with surrogate personal identifiers, in order to prevent the recognition (identification) of a person directly or indirectly, for example, via association with an identifier, user agent, or device. In general, a person can be identified on the basis of biometric personal identifiers, but also by combination of different types of biometric personal identifiers and non-biometric personal identifiers, such as environmental and/or specific socio-political context, speech context, and dressing style. The main physiological biometric identifier, which can be collected at a distance and use for identification, requiring de-identification for privacy preservation is face. The early research into face de-identification was focused on face still images, and recommended the use of ad-hoc or so-called naive approaches such as "black box", "blurring" and "pixelation" of the image region occupied by the face. To achieve an improved level of privacy protection, more sophisticated approaches have been proposed: eigenvector-based de-identification method, k-Same-Select, Model-based k-Same, morphing-based methods and scrambling. Special attention is devoted to automatic face de-

identification in video surveillance systems, as well as drone-based surveillance systems, due to tremendous development and use of visual technologies such as CCTVs, visual sensor networks, camera phones and drones. A survey of approaches, methods and solutions for face de-identification in still images, wild scenes and videos are presented.

Tuesday, September 19th, 2017, 8:45 – 9:45

Speaker: Prof. Dr. Elmar Nöth,
Friedrich-Alexander-Universität Erlangen-Nuernberg, Germany

Title: Remote Monitoring of Neurodegeneration through Speech

Dr. Elmar Nöth is a professor for Applied Computer Science at the University of Erlangen-Nuremberg. He studied in Erlangen and at M.I.T. and received the Dipl.-Inf. and the Dr.-Ing. degree from the University of Erlangen-Nuremberg in 1985 and 1990, respectively. Since 1990 he was an assistant professor at the Institute for Pattern Recognition in Erlangen. Since 2008 he is a full professor at the same institute and head of the speech group. He is one of the founders of the Sympalog Company, which markets conversational dialogue systems. He is author or co-author of more than 350 articles. His current interests are prosody, analysis of pathologic speech, computer aided language learning and emotion analysis.

Abstract: In this talk we will report on the results of the workshop on Remote Monitoring of Neurodegeneration through Speech, which was part of the "Third Frederick Jelinek Memorial Summer Workshop" and took place at Johns Hopkins University in Baltimore, USA from June 13th to August 5th, 2016. We will concentrate on Colombian-Spanish multi-modal data from people with Parkinson's disease that contain speech, gait, and hand-writing data.

Wednesday, September 20th, 2017, 8:45 – 9:45

Speaker: Prof. Dr. Bernhard Rinner,
Alpen-Adria-Universität Klagenfurt, Austria

Title: Privacy Protection in Visual Data

Dr. Bernhard Rinner is professor at the Alpen-Adria-Universität Klagenfurt, Austria where he is heading the Pervasive Computing group. He is deputy head of the Institute of Networked and Embedded Systems and served as vice dean of the Faculty of Technical Sciences from 2008-2011. Before joining Klagenfurt he was with Graz University of Technology and held research positions at the Department of Computer Sciences at the University of Texas at Austin in 1995 and 1998/99. His current research interests include embedded computing, sensor networks and pervasive computing. Bernhard Rinner has been co-founder and general chair of the ACM/IEEE International

Conference on Distributed Smart Cameras and has served as chief editor of a special issue on this topic in The Proceedings of the IEEE. Currently, he is Associate Editor for Ad Hoc Networks Journal and EURASIP Journal on Embedded Systems. Together with partners from four European universities, he has jointly initiated the Erasmus Mundus Joint Doctorate Program on Interactive and Cognitive Environments (ICE). He is member of IEEE and IFIP and member of the board of the Austrian Science Fund.

Abstract: Installed on public places, integrated in cellphones or deployed in the Internet of Things – cameras have become ubiquitous, and they capture highly sensitive information about our everyday life. Advanced analytics and steadily increasing networking pose soaring risks to our privacy. In this talk I will give an overview of privacy challenges in visual data. I will then present selected key achievements from our ten years' research in privacy-aware cameras. A key approach for privacy protection is to deteriorate the image quality of selected areas or entire frames. We have developed "cartooning" as an onboard protection method which requires low computational resources and keeps the utility of the protected video high. In another research thread we have investigated adaptive privacy filters which modify the strength of the deterioration based on the captured scenes. I will conclude the talk by demonstrating our TrustEYE, an embedded smart camera which performs onboard privacy filtering and secures all delivered data with dedicated hardware.

ISPA 2017 Program

Program at a Glance

Monday, September 18th	Tuesday, September 19th	Wednesday, September 20th
8:30 – 8:45 Hello from General Chairs		
8:45 – 9:45 Keynote Talk: Dr. Slobodan Ribarić	**8:45 – 9:45** Keynote Talk: Dr. Elmar Nöth	**8:45 – 9:45** Keynote Talk: Dr. Bernhard Rinner
9:45 – 10:55 Oral Session 1: Mobile and Robotic Vision	**9:45 – 10:55** Oral Session 3: Signal Processing	**9:45 – 10:55** Oral Session 5 (Sp. S.): Endoscopic imaging
10:55 – 11:25 Coffee Break	**10:55 – 11:25** Coffee Break	**10:55 – 11:25** Coffee Break
11:25 – 12:35 Oral Session 2: Signal Analysis	**11:25 – 12:35** Oral Session 4: Medical	**11:25 – 12:35** Oral Session 6: PR and Statistical Modeling
12:35 – 13:05 Monday Poster Spotlight	**12:35 – 13:05** Tuesday Poster Spotlight	**12:35 – 12:50** Goodbye from General Chairs
13:05 – 15:05 Lunch Break	**13:05 – 15:05** Lunch Break	
15:05 – 17:05 Poster Session 1	**15:05 – 17:05** Poster Session 2	
Reception party	**Sightseeing tour**	
	Conference dinner	

Detailed Program

Monday, September 18th 2017

8:30 – 8:45: **Hello from General Chairs**

8:45 – 9:45: **Invited Talk**

Dr. Slobodan Ribarić: Face De-identification for Privacy Protection

9:45 – 10:55: **Oral Session 1 – Mobile and Robotic Vision**

1. Improving vision-based obstacle detection on USV using inertial sensor (Borja Bovcon, Matej Kristan, Rok Mandeljc, Janez Perš)
2. Robust real-time chest compression rate detection from smartphone video (Øyvind Meinich-Bache*, Kjersti Engan)
3. 3D Registration on Mobile Platforms Using an Accelerometer (Tomislav Pribanic, Tomislav Petkovic, Matea Donlic*, Tome Radman, Joaquim Salv)

10:55 – 11:25: **Coffee Break**

11:25 – 12:35: **Oral Session 2 – Signal Analysis**

1. A Smartphone-based Fall Detection System for the Elderly (Panagiotis Tsinganos*, Athanasios Skodras)
2. Analytic Spectrum as a Tool for Time-Frequency Signal Analysis (Viacheslav Antsiperov*)
3. Audio Chord Estimation Based on Meter Modeling and Two-Stage Decoding (Pierangelo Migliorati*, Riccardo Leonardi)

12:35 – 13:05: **Monday Poster Spotlight**

Posters from Poster Session 1

13:05 – 15:05: **Lunch Break**

15:05 – 17:05: **Poster Session I**

P1: Atlas-based global and local RF segmentation of head and neck organs on multimodal MRI images (Szabolcs Urbán*, Attila Tanacs)

P2: Towards Hardware-Friendly Retinex Algorithms (Nikola Banić, Sven Loncaric)

P3: Projected Texture Fusion (Manfred Klopschitz*, Roland Perko, Gerald Lodron, Gerhard Paar, Heinz Mayer)

P4: Evaluation of Image Quality Metrics for Sharpness Enhancement (Yao Cheng, Marius Pedersen*, Guangxue Chen)

*Corresponding author

P5: A Convolutional Neural Network Based Approach to QRS Detection (Marko Šarlija*)

P6: Multispectral scene recognition based on dual convolutional neural networks (Igor Ševo, Aleksej Avramovic*)

P7: Masking in Chrominance Channels of Natural Images – Data, Analysis, and Prediction (Vlado Kitanovski*)

P8: Semi-automated measurement of the Cobb angle from 3D mesh models of the scoliotic spine (Uroš Petković*, Robert Korez, Tomaz Vrtovec)

P9: An Efficient Method for Horizon Line Detection using an Energy Function (Evgeny Gershikov*)

P10: Image Mosaicing of Tunnel Wall Images using High Level Features (Leanne Attard, Carl Debono*, Gianluca ValentinoMario Di Castro)

P11: Real-Time Face Tracking under Long-Term Full Occlusions (Martin Soldic*, Darijan Marcetic, Slobodan Ribaric)

P12: Semantic Image Segmentation for Pedestrian Detection (Adi Nurhadiyatna*)

P13: Blind Determination of Quality of JPEG Compressed Images (Dipabali Sarkar, Sarbani Palit*)

PO1: A Smartphone-based Fall Detection System for the Elderly (Panagiotis Tsinganos*, Athanasios Skodras)

PO2: Robust real-time chest compression rate detection from smartphone video (Øyvind Meinich-Bache*, Kjersti Engan)

PO3: Detection of glomeruli in renal pathology by mutual comparison of multiple staining modalities (Maja Temerinac-Ott*, Cédric Wemmert, Germain Forestier, Friedrich Feuerhake, Jessica Schmitz, Jan-Hinrich Bräsen, Meyke Hermsen)

Social Event: Reception Party

*Corresponding author

Tuesday, September 19th 2017

8:45 – 9:45: **Invited Talk**

Dr. Elmer Nöth: Remote Monitoring of Neurodegeneration through Speech

9:45 – 10:55: **Oral Session 3 – Signal Processing**

1. Simple Multiplierless CIC Compensators Providing Minimum Passband Deviation (Aljoša Dudarin, Goran Molnar*, Mladen Vučić)
2. A Pulse Compression Procedure for an Effective Measurement of Intermodulation Distortion (Pietro Burrascano, Marco Ricci, Stefano Laureti, Alessandro Terenzi, Stefania Cecchi*)
3. TFD Thresholding In Estimating The Number of EEG Components And The Dominant IF Using The Short-Term Rényi Entropy (Jonatan Lerga*, Nicoletta Saulig, Rebeka Lerga, Ivan Štajduhar)

10:55 – 11:25: **Coffee Break**

11:25 – 12:35: **Oral Session 4 – Medical**

4. Detection of glomeruli in renal pathology by mutual comparison of multiple staining modalities (Maja Temerinac-Ott*, Cédric Wemmert, Germain Forestier, Friedrich Feuerhake, Jessica Schmitz, Jan-Hinrich Bräsen, Meyke Hermsen)
5. Dental age estimation from panoramic X-ray images using statistical models (Marko Subasic*)
6. Far-field infrared system for the high-accuracy in-situ measurement of ocular pupil diameter (Csilla Fülep*, Gábor Erdei)

12:35 – 13:05: **Tuesday Poster Spotlight**

Posters from Poster Session 2

13:05 – 15:05: **Lunch Break**

15:05 – 17:05: **Poster Session 2**

P14: Gaussian Mixture Background for Salient Object Detection (Zhuo Su*, Hong Zheng, Guorui Song)

P15: Prolate-Spheroidal UWB Pulse Shapers With Highly Orthogonal Impulse Responses (Goran Molnar*, Ante Milos, Mladen Vučić)

P16: Full Search Equivalent Fast Block Matching using Orthonormal Tree-structured Haar Transform (Izumi Ito*, Karen Egiazarian)

P17: Straight subjective contour detector (Boshra Rajaei*, Rafael Grompone von Gioi, Gabriele Facciolo, Jean-Michel Morel)

*Corresponding author

P18: Door Detection in Images of 3D Scenes in an Electronic Travel Aid for the Blind (Piotr Skulimowski*, Mateusz Owczarek, Paweł Strumiłło)

P19: Optimal cut in minimum spanning trees for 3-D cell nuclei segmentation (Arnaud Abreu*)

P21: Generation and Evaluation of an MRI Statistical Organ Atlas in the Head-Neck Region (Attila Tanacs*)

P22: The Constrained Stochastic Matched Filter Subspace Tracking (Maissa Chagmani*, Bernard Xerri, Bruno Borloz, Claude Jauffret)

P23: Image Registration with Subpixel Accuracy of DCT-Sign Phase Correlation with Real Subpixel Shifted Images (Izumi Ito*)

P24: Barley defects identification (Piotr M. Szczypiński*)

P25: Estimation of Students' Attention in the Classroom From Kinect Features (Janez Zaletelj*)

P26: Chosing an Accurate number of Mel Frequency Cepstral Coeficients for Audio Classification Purpose (Lacrimioara Grama*, Corneliu Rusu)

PO4: A Pulse Compression Procedure for an Effective Measurement of Intermodulation Distortion (Pietro Burrascano, Marco Ricci, Stefano Laureti, Alessandro Terenzi, Stefania Cecchi*)

PO5: Decision support system for the diagnosis of neurological disorders (David Kupas*, Gyorgy Czifra, Gabor Andrassy, Balázs Harangi)

PO6: Using Hierarchical Histogram Representation for the EM Clustering Algorithm Enhancement (Anna Denisova*, Vladislav Sergeyev)

Sightseeing Tour

Social Event: Conference Dinner

*Corresponding author

Wednesday, September 20th 2017

8:45 – 9:45: **Invited Talk**

Dr. Bernhard Rinner: Privacy Protection in Visual Data

9:45 – 10:55: **Oral Session 3 (special session) – Endoscopic Imaging**

1. Differentiating ureter and arteries in the pelvic area via endoscope camera using deep neural network (Balázs Harangi*, Andras Hajdu, Peter Torok, Rudolf Lampe)
2. Efficient Texture Regularity Estimation for Second Order Statistical Descriptors (Attila Tiba*, Balázs Harangi, Andras Hajdu)
3. Pixelwise segmentation of uterine wall in endoscopic video frame using convolutional neural networks (Peter Burai*, Balázs Harangi)

10:55 – 11:25: **Coffee Break**

11:25 – 12:35: **Oral Session 4 – Pattern Recognition and Statistical Modelling**

1. Decision support system for the diagnosis of neurological disorders (David Kupas*, Gyorgy Czifra, Gabor Andrassy, Balázs Harangi)
2. Using Hierarchical Histogram Representation for the EM Clustering Algorithm Enhancement (Anna Denisova*, Vladislav Sergeyev)
3. Object recognition using shape growth pattern (Abbas Cheddad*, Huseyin Kusetogullari, Håkan Grahn)

12:35 – 12:50: **Goodbye from General Chairs**

*Corresponding author

Abstracts

Improving vision-based obstacle detection on USV using inertial sensor

(Borja Bovcon, Matej Kristan, Rok Mandeljc, Janez Perš)

We present a new semantic segmentation algorithm for obstacle detection in unmanned surface vehicles. The novelty lies in the graphical model that incorporates boat tilt measurements from the on-board IMU. The IMU readings are used to estimate the location of horizon line in the image, and automatically adjusts the priors in the probabilistic semantic segmentation algorithm. We derive the necessary horizon projection equations, an efficient optimization algorithm for the proposed graphical model, and a practical IMU-camera-USV calibration. A new challenging dataset, which is the largest multi-sensor dataset of its kind, is constructed. Results show that the proposed algorithm significantly outperforms state of the art, with 32% improvement in water-edge detection accuracy, an over 15% reduction of false positive rate, an over 70% reduction of false negative rate, and an over 55% increase of true positive rate, while running in real-time on a single core in Matlab.

Robust real-time chest compression rate detection from smartphone video

(Øyvind Meinich-Bache*, Kjersti Engan)

Globally one of our major mortality challenges is out-of-hospital cardiac arrest. Good quality cardiopulmonary resuscitation (CPR) is extremely important for the chance of survival after cardiac arrest. Research has shown that telephone assisted guidance from the dispatcher to the bystander can improve the CPR quality provided to the patient. Some recent work has proposed to use the accelerometer in a bystander's smartphone to estimate compression rates, but this demands the phone to be placed on the patient during compression. Our research group has previously proposed a real-time application for bystander and dispatcher feedback using the smartphone camera to estimate the chest compression rate while the smartphone is placed flat on the ground. Some shortcomings were observed with the application in high noise situations. In this paper we propose a robust method where we have modeled and parametrized the power specter density to distinguish between noisy situations, improved the update procedure for the dynamic region of interest and added post-processing steps to suppress noise. The proposed method provides excellent results with acceptable performance at 99.8% of the time testing different rates in high and low noise situations, 99.5% in a disturbance test, and 92.5% of the time during random movements.

3D Registration on Mobile Platforms Using an Accelerometer

(Tomislav Pribanic, Tomislav Petkovic, Matea Donlic*, Tome Radman, Joaquim Salv)

In the last several years 3D shape reconstruction and 3D registration using mobile platforms, i.e. smartphones and tablets, have been an increasingly active research avenue. Besides camera(s), nowadays mobile devices are equipped with a variety of sensors, including an accelerometer, a magnetometer and a gyroscope which are, among other applications, extensively used for the task of 3D registration too. To this end usually more than two sensors are utilized. In this work we demonstrate the usage of a tablet as 3D structured light scanner, and we further propose 3D registration method using only single sensor data, supplied by an accelerometer. Briefly, using an accelerometer our method first estimates only few candidate rotations in the spatial domain. Next, for each rotation candidate, the optimal translation is computed using a correlation function, efficiently implemented in the frequency domain. The final 3D registration parameters are chosen based on ICP refinement. The experimental results show a very close agreement with ground truth data. The proposed method is not restricted to mobile platforms only, but it is applicable to any 3D device which can be upgraded with an ubiquitous accelerometer.

A Smartphone-based Fall Detection System for the Elderly

(Panagiotis Tsinganos*, Athanasios Skodras)

Falls can be severe enough to cause disabilities especially to frail populations. Thus, prompt health care provision is essential to prevent and restore any harm. The purpose of this study is to develop a smartphone-based fall detection system that can distinguish between falls and activities of daily living (ADL). The typical fall detection system consists of a sensing component and a notification module. Android devices, equipped with sensors and communication services, are the best candidates for the development of such systems. This work incorporates a threshold based algorithm, whose accuracy is enhanced by a k Nearest Neighbor (kNN) classifier. In addition, this paper proposes the implementation of a personalization and power regulation system. It achieves high fall detection accuracy, (97.53% sensitivity and 94.89% specificity), which is comparable to related works.

Analytic Spectrum as a Tool for Time-Frequency Signal Analysis

(Viacheslav Antsiperov*)

The report substantiates the concept of the analytic spectrum and the synthesis of time-frequency representations of signals based on it. A number of properties of the analytic spectrum are considered and their comparison with the corresponding properties of the analytic signal is carried out. On the basis of this comparison, key features of similarity and dissimilarity between these dual concepts are formulated. The report discusses the relation between the analytic spectra of the local past and local future of the signal with the Page and Levin instantaneous spectra concepts. The report also presents the relation of analytic spectra of the signal's local past and future with the popular quadratic cone-shaped (Zhao-Atlas-Marks) time-frequency representations.

Audio Chord Estimation Based on Meter Modeling and Two-Stage Decoding

(Pierangelo Migliorati*, Riccardo Leonardi)

In Music Information Retrieval (MIR) different approaches in modeling the meter structure of a song have been proposed and have been proved to be beneficial for the task of Audio Chord Estimation (ACE). In this paper we propose a novel approach that integrates the meter and beat information into the Hidden Markov Model (HMM) used for ACE. In addition to the proposed meter model, we propose also a modification in the inference procedure of the aforementioned HMM, in order to better capture the temporal correlation between chords progression. Experimental results show that the proposed approach is effective as the classical approaches in modeling the meter structure, but with a substantially reduced model complexity. Moreover, the proposed two-stage decoding procedure produces a significant improvement in the chords estimation accuracy.

Atlas-based global and local RF segmentation of head and neck organs on multimodal MRI images

(Szabolcs Urbán*, Attila Tanacs)

Organ segmentation in the head and neck region is very challenging due to the large variability of the shape and size of organs among patients. Accurate and consistent segmentation of the organ-at-risk (OAR) regions is important in radiation treatment planning. This paper presents a fully automated atlas- and learning-based method for segmenting three OARs (trachea, spinal cord, parotid glands) in multimodal head-and-neck MRI images. The proposed method consists of three main parts. First, a probabilistic atlas is generated. Then, a Random Forest classifier that incorporates the atlas as well as various image features of the multimodal images is applied globally and locally in order to handle local variations. The method was trained and tested on 30 multimodal MRI examinations including T2w, T1w and T1w fat saturated images. Manually defined contours were used as reference. The presented results show good correlation with the reference using DICE similarity measurements. Based on these preliminary results the proposed technique can be adapted to other organs of the head-and-neck region.

Towards Hardware-Friendly Retinex Algorithms

(Nikola Banić, Sven Loncaric)

Retinex theory was among the first to introduce a model for simultaneous brightness adjustment and removal of illumination influence on image colors by supposedly emulating some aspects of the human visual system's behaviour. The main idea of most Retinex methods is to readjust color channel values of individual pixels with respect to their local white references. Recently the Smart Light Random Memory Sprays Retinex (SLRMSR) method with a $O(1)$ per-pixel complexity was proposed. Although theoretically fast, like with many other Retinex methods, the problem is that its local pixel sampling scheme and some of its local maximum calculation structures common to other Retinex methods as well are not particularly hardware-friendly. In this paper a reduced sampling scheme and an approximated local maxima calculation are proposed and included into a modified SLRMSR. While the resulting images are visually very similar to the ones obtained by the original SLRMSR, the modified SLRMSR is structurally simpler and more hardware friendly. The results are presented and discussed.

Projected Texture Fusion

(Manfred Klopschitz*, Roland Perko, Gerald Lodron, Gerhard Paar, Heinz Mayer)

Active consumer grade depth sensors have motivated recent research on volumetric depth map fusion. This led to the development of new, efficient, video-rate integration and tracking methods. These approaches still suffer from the geometric inaccuracies of the input depth maps of consumer grade depth sensors. This paper presents a practical stereo system that combines highly accurate and robust projected texture stereo and efficient volumetric integration and allows to easily capture accurate 3D models of indoor scenes. We describe a stereo method that is optimized for random dot projection patterns and delivers complete and robust results. We also show the complementing hardware setup that delivers accurate, complete depth maps. Results of a real-world scene are compared to ground truth data.

Evaluation of Image Quality Metrics for Sharpness Enhancement

(Yao Cheng, Marius Pedersen*, Guangxue Chen)

Image quality assessment has become a meaningful research field due to the explosive growth of image processing technologies in imaging industries. It is becoming more usual to quantify the quality of an image using image quality metrics, rather than carrying out time-consuming psychometric experiments. However, there is little research on the performance of image quality metrics on quality enhanced images. In this paper, we focus on images that have been enhanced by sharpening. A psychometric experiment was designed with observers giving scores to different images enhanced by sharpening on a display in a controlled dark environment. The results showed that full reference image quality metrics performed well when sharpening did not improve the visual image quality, while in images where sharpening increased the visual quality the performance was lower. No reference image quality metrics show better predictions than full reference image quality metrics in most cases.

A Convolutional Neural Network Based Approach to QRS Detection

(Marko Šarlija*)

In this paper we present a QRS detection algorithm based on pattern recognition as well as a new approach to ECG baseline wander removal and signal normalization. Each point of the zero-centred and normalized ECG signal is a QRS candidate, while a 1-D CNN classifier serves as a decision rule. Positive outputs from the CNN are clustered to form final QRS detections. The data is obtained from the 44 non-pacemaker recordings of the MIT-BIH arrhythmia database. Classifier was trained on 22 recordings and the remaining ones are used for performance evaluation. Our method achieves a sensitivity of 99.81% and 99.93% positive predictive value, which is comparable with or better than most state-of-the-art solutions. This approach opens new possibilities for improvements in heartbeat classification as well as P and T wave detection problems.

Multispectral scene recognition based on dual convolutional neural networks

(Igor Ševo, Aleksej Avramovic*)

Multispectral sensors are becoming more accessible which draws additional attention to the problem of processing and classification of multispectral images. In this research we addressed the problem of automatic scene recognition of multispectral images using convolutional neural networks with tailored architecture. More precisely, we propose and describe a special dual network architecture which is able to efficiently process multispectral images and, at the same time, use the possibilities of networks pretrained on feature-rich image dataset. Experiments showed that dual network can efficiently recognize multispectral scenes, even though a small amount of training images had been available. Comparing to the best accuracy of descriptor based method previously reported, our method made an improvement of nearly 5\%, achieving the classification accuracy over 92\% on benchmark multispectral scene dataset.

Masking in Chrominance Channels of Natural Images – Data, Analysis, and Prediction

(Vlado Kitanovski*)

This paper addresses the visual masking that occurs in the chrominance channels of natural images. We present results from a psychophysical experiment designed to obtain local thresholds of just noticeable log-Gabor distortion in the Cr and Cb channels of natural images. We analyzed the data and investigated the correlation between several low-level image features and the collected thresholds. As expected, features like variance, entropy, or edge density were correlated relatively high with the thresholds. We evaluated the performance of linear and non-linear regression (using neural networks and support vector machines) for thresholds prediction from multiple global image features; we also fitted a modified Watson-Solomon's computational model (based on log-Gabor features) for thresholds prediction. The evaluation showed that neural networks and support vector machines are most suitable for thresholds prediction. The computational model performed reasonably well, with further prospects of its improvement.

Semi-automated measurement of the Cobb angle from 3D mesh models of the scoliotic spine

(Uroš Petković*, Robert Korez, Tomaz Vrtovec)

The Cobb angle is the main diagnostic parameter for evaluating spinal deformities. Traditionally, it is measured on two-dimensional coronal radiographic (X-ray) images. In this study, we present a semi-automated algorithm for the evaluation of the Cobb angle from three-dimensional mesh models of the spine. The method was tested on 22 spine models, and the obtained mean absolute error of 2.89° against reference measurements indicates that the method performs well.

An Efficient Method for Horizon Line Detection using an Energy Function

(Evgeny Gershikov*)

In this work we propose a new method for horizon line detection in marine and land images captured by either visible light or infrared cameras. A common method for horizon line detection is based on edge detection and Hough transform. This method has serious drawbacks when the horizon is not a clear straight line or when the image contains additional straight lines. Our method replaces the Hough transform with a more sophisticated method based on an image operator called seam. A seam is an optimal 8-connected path of pixels in a single image going from left to right or vice versa. An energy function is minimized and the seam optimality is defined by the steepest energy descent. We compare the accuracy and relative speed of our method to existing methods for a group of test images. These images are real-life photographs at different spatial resolutions, levels of blurriness, and varying contrast and brightness conditions. Our experiments show that our method increases the accuracy of horizon detection compared to other similar techniques.

Image Mosaicing of Tunnel Wall Images using High Level Features

(Leanne Attard, Carl Debono*, Gianluca Valentino, Mario Di Castro)

This paper proposes a novel approach for position offset correction of images taken from a moving robotic platform in tunnel environments using image mosaicing. An image mosaic is formed by combining multiple images which capture overlapping components of a scene into a larger image. Unlike current image mosaicing methods, which use low-level features such as corners, our method uses binary edges as high-level features for image registration via template matching. This is necessary since such low-level features are absent or rare in tunnel environments. A shading correction algorithm is applied as a pre-processing step to adjust the uneven illumination present in this environment. This technique is simple and efficient while being robust to small camera rotations and small variations in camera distance from the wall. Experimental results show that our method contributes to good image mosaicing results with a low computational complexity, which is attractive for real-time image-based inspection applications.

Real-Time Face Tracking under Long-Term Full Occlusions

(Martin Soldic*, Darijan Marcetic, Slobodan Ribaric)

The identified weaknesses of most of state-of-the-art trackers are inability to cope with long-term full occlusions, abrupt motion, detecting and tracking a reappeared target. In this paper, we present a robust real-time single face tracking system with several new key features: semi-automatic target tracking initialization based on a robust face detector, an effective target loss estimation based on a response of a position correlation filter, a candidate image patch selection for re-initialization supported with a short- and long-term memories (STM and LTM). These memories are used for tracking re-initialization during online learning procedure. The STM is used to select an image patch as candidate for re-tracking based on stored position correlation filters (from current frame) in case of short-term full occlusions, while the LTM stores aggregated position correlation filters (online learned) is used to recover the tracker from long-term full occlusions. Validation of the tracking system was performed by evaluation on a subset of videos from Online Tracking Benchmark (OTB) dataset and our own video.

Semantic Image Segmentation for Pedestrian Detection

(Adi Nurhadiyatna*)

A typical traffic monitoring system for pedestrian detection uses a stationary camera. In Advanced Driving Assis- tance Systems (ADAS), the camera is mounted in front of the vehicle's window so that the camera and the object move in any arbitrary direction. Semantic image segmentation is widely used for road scene interpretation. In this paper, a method for semantic image segmentation using a convolution neural network is proposed. After a candidate region is segmented we perform pedestrian detection based on shape and size features of the candidate region. The experiments show that the proposed approach can accurately detect pedestrians in real-time (40fps).

Blind Determination of Quality of JPEG Compressed Images

(Dipabali Sarkar, Sarbani Palit*)

Human observers can easily assess the quality of a distorted image even without examining the original image as a reference. In contrast, proper formulation of the problem so that the task of quality assessment of an image can be performed automatically, is a complex task and hence, designing objective No-Reference (NR) quality measurement algorithms is indeed very difficult. Existing approaches identify the degradation from among a set of degradation commonly experienced during image transmission and handling. However, apart from the inadequacy of being unable to indicate the amount of degradation they tend to reflect the overall degradation rather than being sensitive to one kind of degradation. The problem of correctly assessing the level of degradation is crucial since the choice of an appropriate restoration technique is heavily dependent on this. Further, in practical situations, the problem is compounded by the presence of other degradation such as noise acting as confounding factors. The proposed approach is designed to work well in situations where JPEG compressed images have been subjected to noise. Its performance has been tested through simulations on a large number of images from several popular databases. Results have also been compared with those obtained from subjective tests on the same images.

Simple Multiplierless CIC Compensators Providing Minimum Passband Deviation

(Aljoša Dudarin, Goran Molnar*, Mladen Vučić)

A simple multiplierless decimation filter is cascaded-integrator-comb (CIC) filter. However, the CIC filter offering high folding-band attenuations introduces a high passband droop. The most popular technique for reducing the droop is connecting a low-order FIR filter called compensator in cascade with CIC filter. In this paper, we present a method for the design of simple multiplierless compensators based on the minimization of the peak-to-peak passband deviation. We form a simple design problem by representing each compensator coefficient as only one signed power of two. The optimum coefficients are found by using the exhaustive search. We show that the proposed compensators with three and five coefficients significantly reduce the droop in wide passbands despite their extremely simple structures, which contain only two and four adders, respectively.

A Pulse Compression Procedure for an Effective Measurement of Intermodulation Distortion

(Pietro Burrascano, Marco Ricci, Stefano Laureti, Alessandro Terenzi, Stefania Cecchi*)

Modelling real-world audio devices is essential for controlling their nonlinear behaviour and making quality evaluations. In particular, the measurement of nonlinear distortion plays an important role in audio reproduction systems since these nonlinear distortions affect the listening experience. In this context, common interesting measures are the total harmonic distortion, the harmonic distortion of order n and the inter-modulation distortion. Due to the complex nature of audio signals, intermodulation distortion is more interesting than total harmonic distortion and harmonic distortion of order n since it provides a prediction of the distortion related to harmonics combination in the human perception of sounds. In this paper, a procedure for inter-modulation distortion prediction is presented based on the identification of the kernels of a generalized Hammerstein system excited by a suitable input signal. Tests have been carried out both in simulated and real-world scenarios thus confirming the validity of the proposed approach.

TFD Thresholding In Estimating The Number of EEG Components And The Dominant IF Using The Short-Term Rényi Entropy

(Jonatan Lerga*, Nicoletta Saulig, Rebeka Lerga, Ivan Štajduhar)

Time-frequency (TF) based EEG signal analysis using the local or short-term Rényi entropy often requires low-energy cross-terms and noise suppression prior to the estimation of the local number of components and the dominant component instantaneous frequency (IF). This can be easily accomplished by thresholding in the TF domain with the preset TF threshold value, often chosen empirically. The paper investigates the sensitivity of the method based on the local Rényi entropy to the chosen threshold value. The study was performed on real-life left and right hand movements EEG signals. As shown in the paper, the number of the EEG components extracted using the short-term Rényi entropy is highly sensitive to the chosen TF threshold value, unlike the dominant IF which was shown to be highly robust to TF thresholding. Hence, characterization of the EEG signals using the short-term Rényi entropy should include both detecting the number of EEG components and the dominant component IF estimation.

Detection of glomeruli in renal pathology by mutual comparison of multiple staining modalities

(Maja Temerinac-Ott*, Cédric Wemmert, Germain Forestier, Friedrich Feuerhake, Jessica Schmitz, Jan-Hinrich Bräsen, Meyke Hermsen)

We evaluate the detection of glomerular structures in whole slide images (WSIs) of histopathological slides stained with multiple histochemical and immuno-histochemical staining using a convolutional neural network (CNN) based approach. We mutually compare the CNN performance on different stainings (Jones H&E, PAS, Sirius Red and CD10) and we present a novel approach to improve glomeruli detection on one staining by taking into account the classification results from differently stained consecutive sections of the same tissue. Using this integrative approach, the detection rate (F1-score) on a single stain can be improved by up to 30%.

Dental age estimation from panoramic X-ray images using statistical models

(Marko Subasic*)

This paper presents an application of computer vision methods to dental age estimation based on the lower third right molar in panoramic X-ray images. For this purpose, two statistical computer vision models are adjusted and applied: Active Shape Model and Active Appearance Model. Both models use shape and appearance of the object to find the outer contour, with the only difference being in the way appearance is used. Statistical models are used to extract features describing the selected tooth, and neural network is used to provide dental age estimation using the features as input. Our own dataset was created, consisting of panoramic X-ray images with known age. A manual segmentation of the selected tooth has been performed for each image in the training set, and the obtained outer contours were used to train both models. Promising preliminary results are presented.

Far-field infrared system for the high-accuracy in-situ measurement of ocular pupil diameter

(Csilla Fülep*, Gábor Erdei)

It is known that human visual performance is influenced by the ocular pupil diameter. So that we can analyze its effect on visual acuity, we developed a high-accuracy measuring system by which the pupil size can be monitored simultaneously with visual acuity examinations. We used infrared illumination and a far-field imaging setup in order not to disturb the subject. In this paper we present our measuring system comprising a camera, an infrared reflector and a unique evaluation/controlling software. According to our experimental results continuous pupil monitoring is feasible with ±0.2 mm spatial accuracy. The new system allows us to reveal delicate tendencies in pupil accommodation during visual acuity tests.

Gaussian Mixture Background for Salient Object Detection

(Zhuo Su*, Hong Zheng, Guorui Song)

Salient object detection has become a valuable tool in image processing. In this paper, we propose a novel approach to get full-resolution saliency maps. The input image is segmented into superpixels, each of them presents an irregular but homogenous area of the image thus can be treated as an image unit. Intuitively, superpixels touching the image borders will have the potential to capture the background information. Therefore, pixels belong to those superpixels are collected as background samples to train a Gaussian mixture model. The saliency of each superpixel is then defined by computing the weighted probability density of the Gaussian mixture model followed by an enhancement and smoothness step. At the end, a dense conditional random field based refinement tool or cellular automata is selected by an adaptive threshold to remove the false salient regions or find other potential saliency regions to get a more accurate result in pixel-level. We compare our method to five saliency detection algorithms which are classic or similar to ours but published in recent years on a commonly used challenging dataset ECSSD. Experiments show that our approach outperforms others well.

Prolate-Spheroidal UWB Pulse Shapers With Highly Orthogonal Impulse Responses

(Goran Molnar*, Ante Milos, Mladen Vučić)

Ultra-wideband (UWB) impulse radio uses very short pulses that meet spectral mask released by Federal Communications Commission (FCC). In addition, to eliminate inter-symbol interference in the multiple-access applications, these pulses should be orthogonal. One technique to generate these pulses is shaping. The shaping is realized with bandpass filters called pulse shapers. The most popular FCC-compliant orthogonal pulses utilize prolate spheroidal wave functions. In this paper, we propose analog pulse shapers whose impulse responses approximate the prolate spheroidal pulses in the least squares sense. Furthermore, we provide their FCC-compliant transfer functions that yield highly orthogonal impulse responses.

Full Search Equivalent Fast Block Matching using Orthonormal Tree-structured Haar Transform

(Izumi Ito*, Karen Egiazarian)

The goal of block matching is to find small parts (blocks) of an image that are similar to a given pattern (template). A lot of full search (FS) equivalent algorithms are based on transforms. However, the template size is limited to be a power- of-two. In this paper, we consider a fast block matching algorithm based on orthonormal tree-structured Haar transform (OTSHT) which makes it possible to use a template with arbitrary size. We evaluated the pruning performance, computational complexity, and design of tree. The pruning performance is compared the algorithm based on orthonormal Haar transform (OHT).

Straight subjective contour detector

(Boshra Rajaei*, Rafael Grompone von Gioi, Gabriele Facciolo, Jean-Michel Morel)

Subjective contours or illusory contours are an important aspect of human perception. Along subjective contours, image contrast is very weak or completely missing, so that no local edge detector can recover them. Their perception is induced by the presence of small pieces of edges and of tips of other long edges incident on the contour. Indeed, in real-world images, edge information of foreground objects is often partly missing due to poor contrast of the object with respect to its background. Nevertheless, the object contour is still perceived by the presence of object or background details that end up abruptly along the contour. In this paper, we handle the detection of straight subjective contours (SSC), using an a contrario approach to control the false detection rate. The algorithm exploits the tips of line segments produced by the well-known parameter-less LSD method. The subjective straight contours are obtained by grouping free tips of parallel line sets, together with aligned short edge pieces. This detection is fully automatic and is demonstrated on a set of images containing subjective contours.

Door Detection in Images of 3D Scenes in an Electronic Travel Aid for the Blind

(Piotr Skulimowski*, Mateusz Owczarek, Paweł Strumiłło)

In this paper we propose a fast method for detecting doors in images of 3D scenes. First, the equation estimating the orientation and location of the ground surface is computed. This information is used in further processing steps of the algorithm. Then, the edge image is calculated (using the Canny edge detector) and line segments justifying predefined conditions are searched for by applying the Probabilistic Hough Transform method. Pairs of parallel line segments perpendicular to the ground surface located at a distance range 80-110cm are identified. The detection performance has been also enhanced by detecting door handles. The proposed method was successfully verified on the recorded indoor RGB-D video sequences acquired by a vision based Electronic Travel Aid (ETA) for the blind. The achieved door detection performance for the tested sequences is at a level of 63% for sensitivity and 84% for positive predictivity values.

Optimal cut in minimum spanning trees for 3-D cell nuclei segmentation

(Arnaud Abreu*)

In biology and pathology immunofluorescence mi- croscopy approaches are leading techniques for deciphering of the molecular mechanisms of cell activation and disease progression. Although several commercial softwares for image analysis are presently in the market, available solutions do not allow a totally non subjective image analysis. There is therefore strong need for new methods that could allow a completely non-subjective image analysis procedure including for thresholding and for choice of the objects of interest. To address this need, we describe a fully automatic segmentation of cells nuclei in 3-D confocal immunofluorescence images. The method merges segments of the image to fit with a nuclei model learned by a trained random forest classifier. The merging procedure explore efficiently the fusion configurations space of an over-segmented image by using minimum spanning trees of its region adjacency graph.

Generation and Evaluation of an MRI Statistical Organ Atlas in the Head-Neck Region

(Attila Tanacs*)

Segmenting organs in MRI images is a common task in medical practice where image registration techniques can be used in the preprocessing steps to reduce the required interactivity. This is especially true in the head and neck region where large variability of shape and size of organs is present among patients. When an image database of MRI images and segmented organ contours are available, these can be used to build probability atlases in a selected reference frame. The atlas data can then be transformed to the coordinate systems of studies to be segmented applying the transformations in the inverse direction. In this paper two registration approaches for atlas building are evaluated and compared. Separate atlases for 6 organs (spinal cord, trachea, carotis, jugularis, parotis, sternocleidomastoid muscle -- SCM) are built from 15 MRI T2 weighted Fast Relaxation Fast Spin Echo (FRFSE) studies using expert segmented organ contours and evaluated using further 15 such studies. The evaluation takes into account the overlap of the expert segmented organ regions and the transformed probability atlases, the discrimination capabilities of the atlases in the carotis-jugularis region, and the errors induced by the inverse registration approach. The results show the superiority of the multiresolution B-Spline transformation implemented by the elastix package against a less flexible, composite transformation formed using scaled rigid + single resolution B-Spline approach. The presented framework can be used for e.g., determining regions of interests (ROIs) as a preprocessing step of learning based fully automatic segmentation approaches.

The Constrained Stochastic Matched Filter Subspace Tracking

(Maissa Chagmani*, Bernard Xerri, Bruno Borloz, Claude Jauffret)

This paper introduces a new fast algorithm named CSMFST which estimates the p-dimensional optimal subspace, i.e. where the signal-to-noise ratio is maximized in the case of n-dimensional nonstationary signals. We assume that we treat both signal and noise which are characterized by their samples. This algorithm is an SP-type algorithm and uses the same principles as the Yet Another Subspace Tracking (YAST) algorithm when estimating the covariance matrices. At each step, it estimates a matrix which spans the optimal subspace.

Image Registration with Subpixel Accuracy of DCT-Sign Phase Correlation with Real Subpixel Shifted Images

(Izumi Ito*)

We evaluate the subpixel accuracy of Discrete Cosine Transform (DCT) -sign phase correlation (-SPC) for image registration. So far, the accuracy was evaluated using images captured by a commercial-off-the-shelf camera, which yields poor results. In the present paper, we use the subpixel- shifted images captured by an industry product camera in order to avoid the problems with a commercial-off-the-shelf camera. We demonstrate the DCT-SPC will be an alternative for phase correlation.

Barley defects identification

(Piotr M. Szczypiński*)

In brewing industry, quality of barley accepted for malt production is essential. The visual inspection of grain for malting is performed by a qualified expert. The process is time-consuming, expensive, and still may yield unreproducible results. Therefore, there is a need for automatic systems, based on computer vision, able to verify grain properties. We present a concept of such the system, which implements image preprocessing, texture, color and shape feature extraction, supervised learning and selected classification algorithms. The results of classification are presented and discussed.

Estimation of Students' Attention in the Classroom From Kinect Features

(Janez Zaletelj*)

This paper proposes a novel approach to automatic estimation of attention of students during lectures in the classroom. The approach uses 2D and 3D features obtained by the Kinect One sensor characterizing both facial and body properties of a student, including gaze point and body posture. Machine learning algorithms are used to train attention model, providing classifiers which estimate attention level of individual student. Human encoding of attention level is used as a training set data. The experiment included 3 persons whose attention was annotated over 4 minute period in a resolution of 1 second. We review available Kinect features and propose features matching the visual attention and inattention cues, and present the results of classification experiments.

Chosing an Accurate number of Mel Frequency Cepstral Coeficients for Audio Classification Purpose

(Lacrimioara Grama*, Corneliu Rusu)

In this paper we study several audio classification scheme applied on different number of features for multiclass classification with imbalanced datasets. As features we proposed the liftering Mel frequency cepstral coefficients, while for classification we use probabilistic methods, instance-based learning algorithms, support vector machines, neural networks, L infinity-norm based classifier, fuzzy lattice reasoning classifier, and trees. The final goal is to find the appropriate number of liftering Mel frequency cepstral coefficients to provide the desired accuracy for audio classification purpose. The best results are obtained using 16 features and k-Nearest Neighbor as a classifier. In this case the correct classification rate is 99.79%, the false alarm rate is 0.05%, the miss rate is 0.21%, the precision is 99.80% and the F-measure is 99.79%.

Differentiating ureter and arteries in the pelvic area via endoscope camera using deep neural network

(Balázs Harangi*, Andras Hajdu, Peter Torok, Rudolf Lampe)

Endoscope-based surgery has several beneficial effects regarding the rehabilitation of the patients, but has some drawbacks causing difficulties to medical experts, on the contrary. The main disadvantage is that the tactile information is lost to the expert who takes the surgical intervention. There are some organs (e.g. ureters and arteries) in the human body which have similar visual appearances, so the differentiation of them based on only visual expression via endoscopy is a challenging task to the medical experts. To support keyhole-surgery using state-of-the-art image processing solutions, we have developed a semi-automatic software which can distinguish ureters from arteries by a dedicated convolutional neural network (CNN). We have trained the CNN on 2000 images acquired during endoscopic surgery and tested on 500 test ones. 94.2% accuracy has been achieved in this two-classes classification task regarding a binary error function.

Efficient Texture Regularity Estimation for Second Order Statistical Descriptors

(Attila Tiba*, Balázs Harangi, Andras Hajdu)

Co-occurrence matrices are commonly used in texture classification tasks. To generate such a matrix, we need a position vector to check possible intensity frequencies in its endpoints. In this paper, we propose an efficient algorithm to locate such position vectors according which the pattern of the texture repeats and thus, the descriptors derived from the co-occurrence matrix are capable to characterize the regularity of the pattern. Our aim is to look for vectors that span well-approximating grids defined by reference points obtained by quantizing the input image. To extract such grids we use the LLL algorithm, which has a polynomial running time. Thus, we have a much more efficient solution than e.g. a brute force based search. We demonstrate our approach on characterizing regular/irregular patterns appearing in medical images. Our results show that the proposed approach is capable to suggest position vectors for an efficient co-occurrence matrix based texture analysis.

Pixelwise segmentation of uterine wall in endoscopic video frame using convolutional neural networks

(Peter Burai*, Balázs Harangi)

Though the number of in vitro fertilization (IVF) has been rising continuously from the beginning of the new millennium, however the success rate of the implantations remained low. According to the statistics, the main reason of unsuccessful IVF relates to the woman factors. The aim of our research project is to provide an automatic image processing based decision support system for the gynecologists which tries to help medical experts to determine the most appropriate time for the insemination. In this paper, we present the first component of this tool, which deals with the preprocessing of the videos about the uterus for further examinations. It includes the segmentation of the video frames by fully convolutional neural network (FCNN) to determines the region of interest. The chosen model has been trained on 4000 images acquired during real hysteroscopic surgeries and tested on other 716 ones. We have achieved 92% segmentation accuracy regarding the correct recognition of the fundus.

Decision support system for the diagnosis of neurological disorders

(David Kupas*, Gyorgy Czifra, Gabor Andrassy, Balázs Harangi)

Current diagnosis of neurological disorders is an expensive and time-consuming task. Our goal is to make this procedure easier and more accurate using a digital eye scanner. Our system can help in making diagnoses, assists in the practice and shortens the time needed to find the appropriate treatment. First and foremost we collect all important visual effects in the field of neurological examination and create a video to make possible the testing of the eye movement of the patient during the video. Their gaze data is collected by an appropriate eye tracker, then we analyze the gaze information in order to evaluate the mental state of the patient using machine learning based algorithms. According to the experimental results, our proposed technique can separate the healthy and ill patients from each other using their gaze data.

Using Hierarchical Histogram Representation for the EM Clustering Algorithm Enhancement

(Anna Denisova*, Vladislav Sergeyev)

This paper is devoted to EM clustering improvement using hierarchical multivariate histogram for probability density representation. We propose to store and operate with the image histogram by means of a special tree data structure. This allows to speed up computations in the case of multivariate input. We also answer the questions of the algorithm initialization and offer an initialization rule, which exploits the proposed histogram-tree structure. We have tested our algorithm modification and initialization rule using remote sensing images. Obtained results have confirmed that the modified algorithm is faster and the initialization rule provides better clustering in comparison with the traditional EM algorithm implementation.

Object recognition using shape growth pattern

(Abbas Cheddad*, Huseyin Kusetogullari, Håkan Grahn)

This paper proposes a preprocessing stage to augment the bank of features that one can retrieve from binary images to help increase the accuracy of pattern recognition algorithms. To this end, by applying successive dilations to a given shape, we can capture a new dimension of its vital characteristics which we term hereafter: the shape growth pattern (SGP). This work investigates the feasibility of such a notion and also builds upon our prior work on structure preserving dilation using Delaunay triangulation. Experiments on two public data sets are conducted, including comparisons to existing algorithms. We deployed two renowned machine learning methods into the classification process (i.e., convolutional neural network -CNN and random forests -RF-) since they perform well in pattern recognition tasks. The results show a clear improvement of the proposed approach's classification accuracy (especially for data sets with limited training samples) as well as robustness against noise when compared to existing methods.

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