Second Croatian Computer Vision Workshop
September 19, 2013, Zagreb, Croatia
CCVW 2013
2nd Croatian Computer Vision Workshop
Zagreb, Croatia, September 19, 2013

Organizing Institution
Center of Excellence for Computer Vision,
University of Zagreb, Croatia

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Preface

On behalf of the Organizing Committee it is my pleasure to invite you to Zagreb for the 2nd Croatian Computer Vision Workshop. The objective of the Workshop is to bring together professionals from academia and industry in the area of computer vision theory and applications in order to foster research and encourage academia-industry collaboration in this dynamic field. The Workshop program includes oral and poster presentations of original peer reviewed research from Croatia and elsewhere. Furthermore, the program includes invited lectures by distinguished international researchers presenting state-of-the-art in computer vision research. Workshop sponsors will provide perspective on needs and activities of the industry. Finally, one session shall be devoted to short presentations of activities at Croatian research laboratories.

The Workshop is organized by the Center of Excellence for Computer Vision, which is located at the Faculty of Electrical Engineering and Computing (FER), University of Zagreb. The Center joins eight research laboratories at FER and research laboratories from six constituent units of the University of Zagreb: Faculty of Forestry, Faculty of Geodesy, Faculty of Graphic Arts, Faculty of Kinesiology, Faculty of Mechanical Engineering and Naval Architecture, and Faculty of Transport and Traffic Sciences.

Zagreb is a beautiful European city with many cultural and historical attractions, which I am sure all participants will enjoy. I look forward to meet you all in Zagreb for the 2nd Croatian Computer Vision Workshop.

September 2013

Sven Lončarić, General Chair
Acknowledgements

The 2013 2nd Croatian Computer Vision Workshop (CCVW) is the result of the committed efforts of many volunteers.

All included papers are results of dedicated research. Without such contribution and commitment this Workshop would not have been possible.

Program Committee members and reviewers have spent many hours reviewing submitted papers and providing extensive reviews which will be an invaluable help in future work of collaborating authors. Managing the electronic submissions of the papers, the preparation of the abstract booklet and of the online proceedings also required substantial effort and dedication that must be acknowledged. The Local Organizing Committee members did an excellent job to guarantee a successful outcome of the Workshop.

We are grateful to the Technical Co-Sponsors, who helped us in granting the high scientific quality of the presentations, and to the Donators that financially supported this Workshop.
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2nd Croatian Computer Vision Workshop (CCVW 2013)  
Technical Program  

Thursday, 19th September, 2013

8:45 – 9:00 Opening

9:00 – 10:00 Invited Lecture
Large Scale Image Classification and Generalizing to New Classes
Thomas Mensink, UVA Amsterdam

10:00 – 10:15 Coffee Break

10:15 – 11:45 Oral Session 1: Color, Medical Imaging, Segmentation

10:15 – 10:30 Light Random Sprays Retinex: Exploiting the Noisy Illumination Estimation
Nikola Banić and Sven Lončarić

10:30 – 10:45 Using the Random Sprays Retinex Algorithm for Global Illumination Estimation
Nikola Banić and Sven Lončarić

10:45 – 11:00 Diabetic Retinopathy Image Database (DRiDB): A New Database for Diabetic Retinopathy Screening Programs Research
Pavle Prentašić, Sven Lončarić, Zoran VATAVUK, Goran Benčić, Marko Subašić, Tomislav PETKOVIĆ, Lana DJUMOVIĆ, Maja MALENICA-RAVLIĆ, Nikola Budimlija and Rašeljka Tadić

11:00 – 11:15 Adaptive Estimation of Visual Smoke Detection Parameters Based on Spatial Data and Fire Risk Index
Marin Bugarić, Toni Jakovčević and Darko Stipaničev

11:15 – 11:45 Industry Session
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11:45 – 12:30 Invited Lecture
A Time-to-Impact Sensor and Applications in Robotics
Robert Forchheimer, ISY Linköping

12:30 – 13:15 Lunch Break

13:15 – 14:00 Poster Session and Student Poster Session

Poster Session


Marin Bugarić, Maja Braović and Darko Stipaničev. Augmented Reality Based Segmentation of Outdoor Landscape Images.

Robert Cupec, Emmanuel Karlo Nyarko, Damir Filko, Andrej Kitanov and Ivan Petrović. Global Localization Based on 3D Planar Surface Segments.

Valentina Zadrija and Sinisa Šegvić. Multiclass Road Sign Detection Using Multiplicative Kernel.


Vedran Hrgetić and Tomislav Pribanić. Surface Registration Using Genetic Algorithm in Reduced Search Space.

Mario Mustre and Mislav Grgić. Filtering for More Accurate Dense Tissue Segmentation in Digitized Mammograms.


Student Poster Session


Pavle Prentašić, Paolo Čerić and Sven Lončarić. Multi-Projector Visualization System for Panoramic Tiled Visualizations.


Toni Benussi and Zoran Kalafatić. Feature Detection and Tracking for Augmented Reality Applications in Industrial Environments.

**2nd Croatian Computer Vision Workshop (CCVW 2013)**

**Technical Program**

Thursday, 19th September, 2013

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| 14:00 – 15:00 | Invited Lecture
* A Tightrope Walk Between Convexity and Non-Convexity in Computer Vision
* Thomas Pock, TU Graz                                             |
| 15:00 – 16:00 | **Oral Session 2: Classification and Detection**                              |
| 15:00 – 15:15 | Combining Spatio-Temporal Appearance Descriptors and Optical Flow for Human Action Recognition in Video Data
* Karla Brkić, Srđan Rašić, Axel Pinz, Siniša Šegvić and Zoran Kalafatić |
| 15:15 – 15:30 | A Method for Object Detection Based on Pixel Intensity Comparisons
* Nenad Markuš, Miroslav Frljak, Igor Pandžić, Jörgen Ahlberg and Robert Forchheimer |
* Markan Lopar and Slobodan Ribarić |
| 15:45 – 16:00 | Classifying Traffic Scenes Using the GIST Image Descriptor
* Ivan Sikirić, Karla Brkić and Siniša Šegvić |
| 16:00 – 16:15 | Coffee Break                                                                            |
| 16:15 – 17:00 | Short Presentations of Projects and Laboratories                                    |
|               | Development of Expert System for Tracking Players in Swimming Pool Based on CommonKADS Methodology
* Vladimir Pleština and Vladan Papić |
|               | New IPA IIIc project: VISTA – Computer Vision Innovations for Safe Traffic
* Sven Lončarić |
|               | Research Activities of The Faculty of Transport and Traffic Sciences Computer Vision Group
* Edouard Ivanjko and Hrvoje Gold |
| 17:00 – 17:15 | Closing                                                                                  |
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Zoran Kalafatić, Croatia
Invited Speakers

Large Scale Image Classification and Generalizing to New Classes

T. Mensink

In this talk I’ll present recent research on large scale image classification and how to learn classifiers for new classes at negligible cost. First, I’ll give a brief overview of the Fisher Vector (FV) image representation. The FV framework could be seen as a generalisation of the popular Bag-of-Visual words approach, by taking into account more statistics about the distribution of the local descriptors in the image. This representation has many advantages: it is efficient to compute, it leads to excellent results even with efficient linear classifiers, and it can be compressed with a minimal loss of accuracy using product quantization.

Second, I’ll discuss distance based classifiers, such as the $k$-Nearest Neighbours ($k$NN) and Nearest Class Means (NCM), since these methods can incorporate new classes and training images continuously over time at negligible cost. This is not possible with the popular one-vs-rest SVM approach, but is essential when dealing with real-life open-ended datasets. For the NCM classifier, which assigns an image to the class with the closest mean, we introduce a new metric learning approach based on multi-class logistic discrimination. During training we enforce that an image from a class is closer to its class mean than to any other class mean in the projected space. Experiments on the ImageNet 2010 challenge dataset, which contains over 1 million training images of thousand classes, show that, surprisingly, the NCM classifier compares favorably to the non-linear $k$-NN classifier. Moreover, the NCM performance is comparable to that of linear SVMs which obtain current state-of-the-art performance. Experimentally we also study the generalization performance to classes that were not used to learn the metrics and obtain surprisingly good results.
A Time-to-Impact Sensor and Applications in Robotics

R. Forchheimer

Time-to-Impact (TTI) sensing can be performed with an ordinary image sensor and suitable processing. Typically an optical flow field is computed and the TTI is derived from it. However, optical flow requires fairly substantial processing and memory which lowers the rate at which TTI values can be achieved, particularly if low power is required. The talk will present a different view on how to compute the optical flow in a way relevant for TTI estimation. Furthermore, the implementation of the algorithm on a focal plane processor (NSIP) will be presented. Finally, some robotic applications will be addressed.

A Tightrope Walk Between Convexity and Non-Convexity in Computer Vision

T. Pock

Energy minimization methods are among the most successful approaches to solve problems in computer vision, image processing and machine learning. Unfortunately, many interesting problems lead to non-smooth and in particular to non-convex optimization problems. In this talk I will discuss different strategies to tackle non-convex problems, leading to very efficient and in some cases globally optimal algorithms.
Abstracts

Oral Session 1: Color, Medical Imaging and Segmentation

Light Random Sprays Retinex: Exploiting the Noisy Illumination Estimation

N. Banić, S. Lončarić

In this paper Light Random Sprays Retinex (RSR), an improvement of the Random Sprays Retinex (RSR) algorithm is proposed. RSR is a white balancing algorithm for achieving local color constancy and image enhancement by using random sprays of same size. The main problem or the original RSR is that the lower the number and size of the sprays, the greater the noise in the resulting image, which means that the number and size of sprays have to be relatively high in order to lessen the noise leading to a higher computation cost. The proposed improved algorithm is based on a new method to remove the noise in the resulting image thereby allowing only one spray of a smaller size to be used resulting in lower computation cost. By using interpolation the computation cost is reduced even further without a noticeable difference. The improved RSR is tested on a public database and it is shown that it outperforms the original RSR in image quality and computation cost.

Using the Random Sprays Retinex Algorithm for Global Illumination Estimation

N. Banić, S. Lončarić

In this paper the use of Random Sprays Retinex algorithm for global illumination estimation is proposed and its feasibility tested. The algorithms based on the Retinex model provide local illumination estimation for each pixel and they often have a high computation cost while another problem is the noise in the resulting images. As the assumption of the uniform illumination holds in many cases, it should be possible to use the mean of local illumination estimation of Retinex algorithms as a global illumination estimation because in that case their performance can be easily measured and there is also a possibility of a significantly
lower computation cost. Therefore we propose a method for estimating global illumination estimation based on local Retinex results. For our tests we use a publicly available color constancy image data base for testing. The results are presented and discussed and it turns out that the proposed method outperforms many existing unsupervised color constancy algorithms.

Diabetic Retinopathy Image Database (DRiDB): A New Database for Diabetic Retinopathy Screening Programs Research


Diabetic retinopathy is one of the leading disabling chronic diseases, and one of the leading causes of preventable blindness in the world. Early diagnosis of diabetic retinopathy enables timely treatment and in order to achieve it a major effort will have to be invested into screening programs and especially into automated screening programs. For automated screening programs to work robustly a representative fundus image database is required. In this paper we give an overview of currently available databases and present a new diabetic retinopathy database. Our database is to our knowledge the first and only database which has diabetic retinopathy pathologies and major fundus structures annotated for every image from the database which makes it perfect for design and evaluation of currently available and new image processing algorithms for early detection of diabetic retinopathy using color fundus images.

Adaptive Estimation of Visual Smoke Detection Parameters Based on Spatial Data and Fire Risk Index

M. Bugarić, T. Jakovčević, D. Stipaničev

Standard wildfire smoke detection systems detect fires using remote cameras located at observation posts. Images from the cameras are analyzed using standard computer vision techniques, and human intervention is required only in situations in which the system raises an alarm. The number of alarms depends largely on manually set detection sensitivity parameters. One of the primary drawbacks of this approach is the false alarm rate, which impairs the usability of the system. In this paper, we present a novel approach using GIS and augmented reality to include the spatial and fire risk data of the observed scene. This information is used to improve the reliability of the existing systems through automatic parameter adjustment. For evaluation, three smoke detection methods were improved using this approach and compared to the standard versions. The results demonstrated significant improvement in different smoke detection aspects, including detection range, rate of correct detections and decrease in the false alarm rate.
Oral Session 2: Classification and Detection

Combining Spatio-Temporal Appearance Descriptors and Optical Flow for Human Action Recognition in Video Data


This paper proposes combining spatio-temporal appearance (STA) descriptors with optical flow for human action recognition. The STA descriptors are local histogram-based descriptors of space-time, suitable for building a partial representation of arbitrary spatio-temporal phenomena. Because of the possibility of iterative refinement, they are interesting in the context of online human action recognition. We investigate the use of dense optical flow as the image function of the STA descriptor for human action recognition, using two different algorithms for computing the flow: the Farnebäck algorithm and the TVL1 algorithm. We provide a detailed analysis of the influencing optical flow algorithm parameters on the produced optical flow fields. An extensive experimental validation of optical flow-based STA descriptors in human action recognition is performed on the KTH human action dataset. The encouraging experimental results suggest the potential of our approach in online human action recognition.

A Method for Object Detection Based on Pixel Intensity Comparisons

N. Markuš, M. Frljak, I. S. Pandžić, J. Ahlberg, R. Forchheimer

We describe a method for visual object detection based on an ensemble of optimized decision trees organized in a cascade of rejectors. The trees use pixel intensity comparisons in their internal nodes and this makes them able to process image regions very fast. Experimental analysis is provided through a face detection problem. Our system compares well in terms of accuracy with an established real-time face detector and achieves significant advantage when processing speed is considered.

An Overview and Evaluation of Various Face and Eyes Detection Algorithms for Driver Fatigue Monitoring Systems

M. Lopar, S. Ribarić

In this work various methods and algorithms for face and eyes detection are examined in order to decide which of them are applicable for use in a driver fatigue monitoring system. In the case of face detection the standard Viola-Jones face detector has shown best results, while the method of finding the eye
centers by means of gradients has proven to be most appropriate in the case of eyes detection. The later method has also a potential for retrieving behavioral parameters needed for estimation of the level of driver fatigue. This possibility will be examined in future work.

Classifying Traffic Scenes Using The GIST Image Descriptor

I. Sikirić, K. Brkić, S. Šegvić

This paper investigates classification of traffic scenes in a very low bandwidth scenario, where an image should be coded by a small number of features. We introduce a novel dataset, called the FM1 dataset, consisting of 5615 images of eight different traffic scenes: open highway, open road, settlement, tunnel, tunnel exit, toll booth, heavy traffic and the overpass. We evaluate the suitability of the GIST descriptor as a representation of these images, first by exploring the descriptor space using PCA and k-means clustering, and then by using an SVM classifier and recording its 10-fold cross-validation performance on the introduced FM1 dataset. The obtained recognition rates are very encouraging, indicating that the use of the GIST descriptor alone could be sufficiently descriptive even when very high performance is required.

Poster Session

Computer Vision Systems in Road Vehicles: A Review

K. Kovačić, E. Ivanjko, H. Gold

The number of road vehicles significantly increased in recent decades. This trend accompanied a build-up of road infrastructure and development of various control systems to increase road traffic safety, road capacity and travel comfort. In traffic safety significant development has been made and today's systems more and more include cameras and computer vision methods. Cameras are used as part of the road infrastructure or in vehicles. In this paper a review on computer vision systems in vehicles is given. Safety problems of road vehicles are given, current state of the art in-vehicle vision systems is described and open problems with future research directions are discussed.
Augmented Reality Based Segmentation of Outdoor Landscape Images

M. Bugarić, M. Braović, D. Stipaničev

The segmentation and classification of image regions are very important tasks in the field of computer vision, and yet they remain one of its greatest challenges. These challenges arise from the fact that the same objects can come in different colors, shapes and sizes, and can appear in different contexts and under different illumination. In an attempt to overcome these obstacles, in this paper we propose a system for segmentation and classification of image regions on outdoor landscape images based on augmented reality and CORINE land cover (CLC) classification. We compare the results obtained by the proposed system with the results obtained by the $k$-NN algorithm, and show that the proposed algorithm outperforms the $k$-NN one, and generally gives favorable segmentation and classification results.

Global Localization Based on 3D Planar Surface Segments

R. Cupec, E. K. Nyarko, D. Filko, A. Kitanov, I. Petrović

Global localization of a mobile robot using planar surface segments extracted from depth images is considered. The robot’s environment is represented by a topological map consisting of local models, each representing a particular location modeled by a set of planar surface segments. The discussed localization approach segments a depth image acquired by a 3D camera into planar surface segments which are then matched to model surface segments. The robot pose is estimated by the Extended Kalman Filter using surface segment pairs as measurements. The reliability and accuracy of the considered approach are experimentally evaluated using a mobile robot equipped by a Microsoft Kinect sensor.

Multiclass Road Sign Detection using Multiplicative Kernel

V. Zadrija, S. Šegvić

We consider a problem of multiclass road sign detection using multiplicative kernel comprised from two kernels. We show that problems of detection and within-foreground classification can be jointly solved by using one kernel to measure object - background differences and another one to account for within-class variations. The main idea behind this approach is that road signs from different foreground variations can share features that discriminate them from backgrounds. As a model, we use SVM classifier, thus feature sharing is obtained through support vector sharing. Training yields a family of linear detectors,
where each detector corresponds to a specific foreground training sample. However, there may be redundancy between various detectors, which is accounted for using k-medoids clustering technique. Finally, we report detection and classification results on a set of road sign images obtained from a camera on a moving vehicle.

A Novel Georeferenced Dataset for Stereo Visual Odometry

I. Krešo, M. Ševrović, S. Šegvić

In this work, we present a novel dataset for assessing the accuracy of stereo visual odometry. The dataset has been acquired by a small-baseline stereo rig mounted on the top of a moving car. The groundtruth is supplied by a consumer grade GPS device without IMU. Synchronization and alignment between GPS readings and stereo frames are recovered after the acquisition. We show that the attained groundtruth accuracy allows to draw useful conclusions in practice. The presented experiments address influence of camera calibration, baseline distance and zero-disparity features to the achieved reconstruction performance.

Surface Registration Using Genetic Algorithm in Reduced Search Space

V. Hrgetić, T. Pribanić

Surface registration is a technique that is used in various areas such as object recognition and 3D model reconstruction. Problem of surface registration can be analyzed as an optimization problem of seeking an Euclidean motion between two different views. Genetic algorithms have proven to be a suitable method for solving optimization problems and can be used for obtaining robust parameter estimation as well as for their fine-tuning. Their main drawback is that they are time consuming which makes them unsuitable for online applications. Modern acquisition systems enable the implementation of solutions that would immediately give information on the rotational angles between the different views, thus reducing the dimension of the optimization problem. The paper gives an analysis of the genetic algorithm implemented in the conditions when the rotation matrix is known and comparison of these solutions with solutions when this information is not available.
Filtering for More Accurate Dense Tissue Segmentation in Digitized Mammograms

M. Muštra, M. Grgić

Breast tissue segmentation into dense and fat tissue is important for determining the breast density in mammograms. Knowing the breast density is important both in diagnostic and computer-aided detection applications. There are many different ways to express the density of a breast and good quality segmentation should provide the possibility to perform accurate classification no matter which classification rule is being used. Knowing the right breast density and having the knowledge of changes in breast density could give a hint of a process which started to happen within a patient. Mammograms generally suffer from a problem of different tissue overlapping which results in possibility of inaccurate detection of tissue types. Fibroglandular tissue presents rather high attenuation of X-rays and is visible as brighter in the resulting image but overlapping fibrous tissue and blood vessels could easily be replaced with fibroglandular tissue in automatic segmentation algorithms. Small blood vessels and microcalcifications are also shown as brighter objects with similar intensities as dense tissue but do have some properties which makes possible to suppress them from the final results. In this paper we try to divide dense and fat tissue by suppressing scattered structures which do not represent glandular or dense tissue in order to divide mammograms more accurately in two major tissue types. For suppressing blood vessels and microcalcifications we have used Gabor filters of different size and orientation and a combination of morphological operations on filtered image with enhanced contrast.

Flexible Visual Quality Inspection in Discrete Manufacturing

T. Petković, D. Jurić, S. Lončarić

Most visual quality inspections are composed of a few simple elements such as length, surface, angle or intensity measurements. Those are implemented as end-user configurable inspection tools that do not require an image processing expert to set up. Currently available software solutions providing such capability use a flowchart based programming environment, but do not fully address inspection program robustness and require a redefinition of a processing flowchart if small variation in production is introduced.

In this paper we propose an acquire-register-analyze image processing pattern that aims to increase the robustness of an image processing flowchart by consistently addressing variations in product position, orientation and size. Proposed pattern is transparent to the end-user and simplifies the flowchart program. We describe a developed software that is a practical implementation of the proposed
pattern and give an example of its real-life use in industrial production of electric components.
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