Fall 2015 Meeting of the NVPHBV

Dutch Society for Pattern Recognition and Image Processing

www.nvphbv.nl

Monday 30 November 2015, Black Box Movie Theatre, TU/e campus, Eindhoven

hosted by

Biomedical Image Analysis group -Department of Biomedical Engineering
Eindhoven University of Technology, Eindhoven, The Netherlands

Abstracts

Keynote Lecture 01:
Amsterdam Computer Vision: from the lab to the real world

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Today, the moment has come that computer vision technology is accurate and fast enough to be applied in an increasing number of applications such as image retrieval, face recognition and surveillance. In this talk, I will discuss the computer vision technology of three different UvA spin-offs converting scientific ideas and concepts, created in a lab environment, into commercial software to be used in real world scenarios for (1) object recognition (2) human behavior analysis and (3) 3D reconstruction.

Keynote Lecture 02:
CAD and risk models for coronary artery disease
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Heart diseases and more specifically coronary artery diseases are still one of the major causes of death in the western world. Imaging plays and important role in the diagnosis and treatment of coronary artery disease. Diagnostic imaging with computed tomography (CT) results in large 3D data sets which have to be inspected by the radiologist or cardiologist. Computer aided diagnosis approaches to analyze the individual arteries helps the medical doctors to look for suspicious regions in these arteries and to rule out regions which are not interesting to investigate. This information can be combined in

risk models. Image processing also plays an important role during the treatment of coronary artery disease. It provides essential measurements for device selection like scaffold length and diameter and treatment planning like the exact location of the stent placement. In this lecture the different aspect of using advanced image processing techniques for the diagnoses and treatment of coronary artery disease will be presented.

Why does synthesized data improve classification of multi-sequence medical images?

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Incomplete datasets can make it difficult to train a classifier, because most classifiers assume that the same data is available for all training samples. The classification and registration of incomplete multi-modal medical images, such as multi-sequence MRI with missing sequences, can sometimes be improved by replacing the missing modalities with synthesized data. This may seem counter-intuitive: synthetic data is derived from data that is already available, so it does not add new information. Why can it still improve performance? We will discuss possible explanations, based on experiments with two classifiers (linear SVMs and random forests) and two synthesis models (neural networks and restricted Boltzmann machines) on data from a brain tumor segmentation challenge with multi-modal MRI scans.

Computer-aided detection of early esophageal cancer

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Over the past decade, the imaging tools for endoscopists have improved drastically. This has enabled visual inspection of the intestinal tissue for early signs of malignant lesions. Furthermore, it has paved the way for image analysis algorithms, to support the gastroenterologist in finding these early signs of developing cancer. We explore various methods for characterizing and segmenting the malignant tissue in endoscopic imagery, where different color and texture features are compared and combined with machine learning methods such as Support Vector Machine (SVM) and Random Forests (RF). Multi-expert validation on 100 images of 39 patients shows promising results where both the sensitivity and specificity of the system exceed 0.80.

Automatic detection of ductal carcinoma in situ in whole slide histopathological images

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This study presents and evaluates a fully automatic method for detection of ductal carcinoma in situ (DCIS) in digitized hematoxylin and eosin (H&E) stained histopathological slides of breast tissue. The proposed method applies multi-scale super-pixel classification to detect regions of interest in whole-slide images (WSIs). Subsequently, spatial clustering is utilized to delineate regions representing

meaningful structures within the tissue. A classifier employing statistical and structural texture features and architectural features is then trained to discriminate between DCIS and benign/normal structures. Evaluation was conducted both on the slide and the lesion level using (F)ROC analysis. The result of the per-slide evaluation shows a sensitivity of 95% and 100% at an average of 2 and 2.6 false positive detections per WSI, respectively. The results of the per-lesion evaluation show that it is possible to detect 80% and 83% of the DCIS lesions in an abnormal slide, at an average of 2.0 and 3.0 false positive detections per WSI, respectively. Collectively, the result of the experiments demonstrate the efficacy and accuracy of the proposed method as well as its potential for application in routine pathological diagnostics.

Context-preserving deep convolutional neural networks for white matter hyper-intensity segmentation

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The anatomical location of imaging features is of crucial importance for accurate diagnosis in many medical tasks. Convolutional neural networks (CNN) have had huge successes in computer vision, but they lack the natural ability to incorporate the anatomical location in their decision making process, hindering success in some medical image analysis tasks.
In this work, to integrate the anatomical location information into the network, we propose several deep CNN architectures that consider multi-scale patches or take explicit location features while training. We apply and compare the proposed architectures for segmentation of white matter hyperintensities in brain MR images on a large dataset. As a result, we observe that the CNNs that incorporate location information substantially outperform a conventional segmentation method with hand-crafted features as well as CNNs that do not integrate location information. On a test set of 46 scans, the best configuration of our networks obtained a Dice score of 0.791, compared to 0.797 for an independent human observer. Performance levels of the machine and the independent human observer were not statistically significant (p-value=0.17).

RetinaCheck, a new platform for early detection of diabetic retinopathy

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Automated detection of retinopathy in retinal images using digital image analysis methods has huge potential benefits. It offers the possibility of examination of a large number of images with time and cost savings and offers more objective measurements than current observation techniques. Advantages in a clinical context include the potential to perform automated screening for conditions such as diabetic retinopathy, and hence to reduce the workload required from manual trained graders.

The high resolution fundus camera images generate a wealth of information, and due to the large size and huge numbers, specialized software is developed to do a fully automatic analysis and diagnosis. The integration of the many individual applications in one integrated system, both for the researcher and clinical user, is the main aim of RetinaCheck platform.
RetinaCheck platform facilitates the automatic retinal image analysis by establishing a common repeatable procedure, thus increasing the performance and reliability of the entire analysis, and it helps with the image storage and management, allowing the collaboration between experts in different locations for the different studies.
This platform includes several tools for automatic retinal image analysis, such as vessel segmentation and tracking, optic disc and fovea detection, optic segmentation, vessel caliber measurement, artery/vein classification, microaneurysm, hemorrhage and drusen detection, assessment of alternation in vessel calibers and etc. Several requirements were considered in the development of this software. This interface automatically computes several parameters from retinal images in a repeatable and objective manner. RetinaCheck allows the integration of new image processing modules easily and it will provide several features and tools to increase interactivity and usability.

Using polynomial approximation to improve classification of spectral data

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In a variety of biomedical applications hyperspectral cameras are used to gain further insight into biological mechanisms. The resulting spectral data is commonly used as input for classification tasks. Traditional approaches often suffer from the nominally high number of input dimensions.
We present a framework for distance based classification of functional data. In detail we consider the analysis of spectral data by the means of Generalized Matrix Learning Vector Quantization as an example. The input data is approximated by a weighted set of basis functions taking into account their functional nature. GMLVQ is applied in the space of approximation coefficients and compared to the standard approach ignoring the functional characteristics of the input data.
Experiments show that this approach leads not only to a drastically reduction in the number of input dimensions and therefore computational effort, but can also improve classification performance significantly.

Active registration models

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We propose a method that couples medical image registration with matching of statistical models of shape and intensity to target images. The statistical models are embedded in the image registration procedure as regularization terms that penalize differences between a sample and a sample reconstructed from the model. The proposed method can be interpreted as a generalization of Active Shape Models and Active Appearance Models to other transformation models, optimization methods and higher dimensional images (3D, 4D and beyond) and allows many shape and intensity models to be fitted in parallel in a computationally efficient manner. Preliminary results on synthetic data indicate

that proposed method is able to recover solutions in cases where regular intensity-based image similarity metrics fail and that the method is able to self-assess registration performance and report to the user the probability that a good registration result was obtained.

Marrying orientation scores and path openings

Jasper van de Gronde (but based on joint work(s) with Mikola Lysenko, André Offringa, and Jos Roerdink)
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Orientation scores give local information on orientations, responding strongly to both small and large features. Path openings operate more globally in that they allow preserving only paths above a certain length threshold. However, they may find paths that are not very well aligned with the local orientations. By combining the two approaches we get the best of both worlds: the ability to find long paths that are everywhere well-aligned with the local orientations. I will present some examples of how these two concepts have been combined. I will also discuss some possible avenues for future work, and highlight some open questions.

3D needle detection with ultrasound imaging

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Ultrasound imaging is employed for needle guidance in various minimally invasive procedures such as biopsy, regional anesthesia and brachytherapy. However, needle guidance using 2D ultrasound is very challenging, due to a poor needle visibility and a limited field of view. Nowadays, 3D ultrasound systems are available and more widely used. Consequently, with an appropriate 3D image-based needle detection technique, needle guidance and interventions may significantly be improved and simplified. We present a multi-resolution Gabor transformation for an automated and reliable extraction of the needle segments in the 3D ultrasound volume. Evaluation of our system in challenging ex-vivo datasets shows a high detection score and an accurate visualization of the needle plane.

Semi-automated registration of pre- and intra-operative liver CT for image-guided interventions

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Percutaneous radio frequency ablation (RFA) is a minimally invasive method for liver tumor treatment, used when conventional operation is not an option. It may be performed under CT image guidance when tumor contrast in ultrasound images is insufficient. In this process, registration of pre-operative contrast-enhanced CT to intra-operative CT images is hypothesized to improve guidance. Due to large differences in pose and image contrast, this task is a highly challenging task, for which fully automated approaches sometimes fail. In this study, we introduce a semi-automated registration algorithm that may be used to improve registration results. The method is a combination of a conventional nonrigid

intensity-based registration framework and a novel point-to-surface constraint. The point-to-surface constraint aims at improving alignment of the liver boundary, while requiring minimal computational burden and user interaction during the intervention. The method is evaluated on 23 clinical datasets and it increases median