Program NVPHBV Spring Meeting 2011

18 May 2011, Van Peperzeelzaal in the UMC Utrecht, Heidelberglaan 100.
Hosted by the Image Sciences Institute (ISI) at the UMC Utrecht

09:30 **Coffee and Tea**

09:45 **Welcome and introduction by the chairman**
Bart M. ter Haar Romeny
TU Eindhoven

09:50 **Carotid Artery Centerline Tracking in Multispectral MRA**
Hui Tang[a,d],Theo van Walsum[a], Robbert S. van Onkelen[b,c], Stefan Klein[a], Reinhard Hameeteman[a], Michiel Schaap[a], Quirijn J.A. van den Bouwhuijsen[a,b], Jacqueline C. M. Witteman[c], Aad van der Lugt[d], Lucas J. van Vliet[d], Wiro J. Niessen[a,d]
[a]Department of Medical Infomatics, [b]Department of Radiology, [c]Department of Epidemiology, Erasmus MC-University Medical Center Rotterdam
[d]Department of Imaging Science and Technology, Faculty of Applied Science Delft University of Technology

10:15 **Vessel-Specific Coronary Artery Calcium Scoring: An Automated Method**
R. Shahzad[*†], T. van Walsum*, M. Schaap*, S. Klein*, L. J. van Vliet[†], and W.J. Niessen*[†]*
*Biomedical Imaging Group Rotterdam, Dept. of Radiology & Medical Informatics, Erasmus MC, Rotterdam
[†]Quantitative Imaging Group Delft, Imaging Science & Technology, Faculty of Applied Science, TU Delft, Delft

10:40 **Coffee and Tea break**

10:55 **Automatic detection of retinal vascular bifurcations by trainable V4-like filters**
George Azzopardi and Nicolai Petkov
Johann Bernoulli Institute for Mathematics and Computer Science, University of Groningen

11:20 **Shadow Removal Based on Inpainting and Gradient Manipulation**
Bart Liefers, Robby T. Tan
Multimedia and Geometric Group, Department of Information and Computing Sciences, Utrecht University

11:45 **Ledenvergadering**
1. Opening and agenda
2. Minutes of previous meeting
3. Board composition
4. Financial statement 2010
5. Proposal for Honorary membership
6. AOB / wvttk
7. Questions

12:15 **Lunch**
Stand up lunch, directly outside the Van Peperzaal

13:15 **Invited lecture**: **Image Processing in Mathematica 8**
Markus van Almsick,
Wolfram Research Inc.

14:15 **Revenge of the nearest neighbour: Large-scale word retrieval in historic handwritten manuscript collections**
Lambert Schomaker
Artificial Intelligence & Cognitive Engineering (ALICE) Faculty of Mathematics and Natural Sciences University of Groningen

14:40 **An Automated System for Postal Stamp Detection and Recognition**
Elena Ranguelova, Jochem van Vroonhoven, Jurrien de Knecht
Research and Development, Prime Vision B.V., Delft, The Netherlands

15:05 **Coffee and Tea break**

15:20 **Hidden-Unit Conditional Random Fields**
Laurens van der Maaten (Delft University of Technology),
Max Welling (University of California, Irvine) and
Lawrence Saul (University of California, San Diego)

15:45 **Constrained Parameter Estimation for Semi-Supervised Learning**
Marco Loog
Pattern Recognition Laboratory, Delft University of Technology

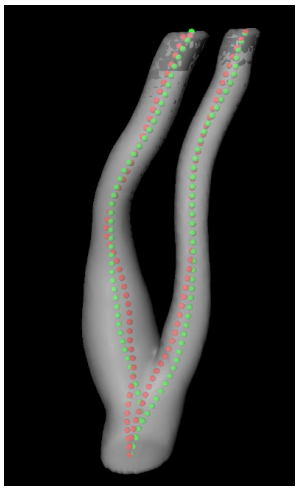
16:10 **Classification of schizophrenia from structural MRI: Support Vector Machine model evolution**
Mireille Nieuwenhuis, UMCU, Psychiatrie
Hugo Schnack, UMCU, Psychiatrie

16:35 Closing and drinks (-17:30)

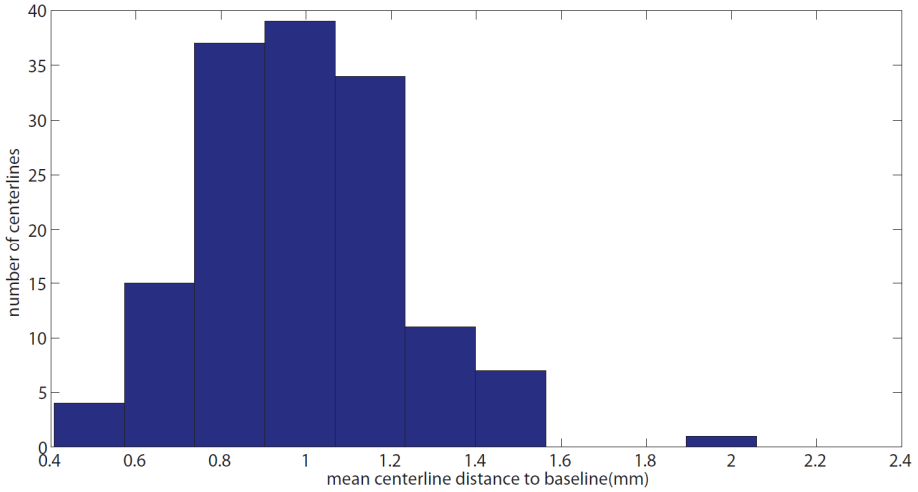
Multispectral MRI Centerline Tracking in Carotid Arteries

Hui Tang*[a,c], Theo van Walsum[a], Robbert S. van Onkelen[a,b], Stefan Klein[a] , Reinhard Hameeteman[a], Michiel Schaap[a], Quirijn J.A. van den Bouwhuijsen[a,b] , Jacqueline C. M. Witteman[b], Aad van der Lugt[a], Lucas J. van Vliet[c], Wiro J. Niessen[a,c]
a) Departments of Radiology and Medical Informatics
b) Department of Epidemiology
Erasmus MC- University Medical Center Rotterdam, The Netherlands
c) Department of Imaging Science and Technology
Faculty of Applied Science, Delft University of Technology, The Netherlands

Atherosclerosis is a major cardiovascular disease[1]. MR imaging is a non-invasive technique to assess atherosclerotic plaque volume and composition and to monitor plaque progression. (Semi-)automated processing of these images is valuable, both in clinical practice and in clinical research. Centerlines can serve as the initialization for segmentation[2–4]. or define the region of interest for further processing[5]. This paper proposes a minimum cost path approach to track the centerlines of the internal and external carotid arteries in multispectral MR data. User interaction is limited to the annotation of three seed points. The cost image is based on both a measure of vessel medialness and lumen intensity similarity in two MRA image sequences: Black Blood MRA and Phase Contrast MRA. After intensity inhomogeneity correction and noise reduction, the two images are aligned using affine registration. Two parameters that control the contrast of the cost image were determined in an optimization experiment on 40 representative training datasets. Experiments on the training datasets also showed that a cost image composed of a combination of gradient-based medialness and lumen intensity similarity increased the tracking successful rate compared to using only one of the constituents. Furthermore, centerline tracking using both MRA sequences outperformed tracking using only one of these MRA images. The training results are listed in Tab.1. An independent test set of 152 images from 38 patients served to validate the technique. The centerlines of 148 images were successfully extracted using the parameters optimized on the training sets. The average mean centerline distance to the reference standard, manually annotated centerlines, was 0.98 mm, which is comparable to the in-plane resolution. Shown in Fig.1(a) is an example of the tracked centerline(red) and the reference standard. The distribution of centerline tracking accuracy is in Fig.1(b), which shown that 90 out of 148 centerlines have a mean centerline distance below 1mm. This indicates that the proposed method has a high potential to replace the manual centerline annotation.



(a) An example of the tracked centerline(Mean distance=0.93mm)



(b) mean distance distribution of 148 centerlines(mm)

Figure 1. An example of a tracked centerline with the average mean distance and the accuracy distribution of the 148 centerlines

	medialness					**medialness+lumen intensity likelihood**				
	min #failures	max #failures	mean centerline distance(mm)	α	β	min #failures	max #failures	mean centerline distance(mm)	α	β
BBMRA	7	10	0.96	3	0	3	5	0.90	2	1
PCMRA	5	6	1.16	2	0	2	4	1.12	1	1
Multispectral	2	5	1.04	2	0	0	0	1.08	1	1

Table1. optimization of alpha and beta in centerline tracking

REFERENCES

[1]. Ross, R., "Atherosclerosis: an inflammatory disease". New Engel J Med, 340(2), 115-126 (1999).

[2]. M. Schaap, C.T. Metz, T. van Walsum, A.G. van der Giessen, A.C. Weustink, N.R.A. Mollet, C. Bauer, H. Bogunović, C. Castro, X. Deng, E. Dikici, T. O'Donnell, M. Frenay, O. Friman, M. Hernández Hoyos, P.H. Kitslaar, K. Krissian, C. Kühnel, M. A. Luengo-Oroz, M. Orkisz, Ö Smedby, M. Styner, A. Szymczak, H. Tek, C. Wang, S. K. Warfield, S. Zambal, Y. Zhang, G. P. Krestin and W.J. Niessen, Standardized Evaluation Methodology and Reference Database for Evaluating Coronary Artery Centerline Extraction Algorithms, Medical Image Analysis, 2009

[3]. Tang, H., et al," A semi-automatic method for segmentation of the carotid bifurcation and bifurcation angle quantification on Black Blood MRA", Proc. MICCAI, in press,(2010).
Ladak, H.M., et al, "A Semiautomatic Technique for Measurement of Arterial Wall from BBMRI". Med Phys, 28(6), 1098-1107 (2001).

[4]. R. Shahzad, M. Schaap, T. van Walsum, S. Klein, A.C. Weustink, L. J. van Vliet and W.J. Niessen, A patient-specific coronary density estimate, Proceedings of IEEE International Symposium on Biomedical Imaging: from Nano to Macro, 2010 , 2010

VESSEL-SPECIFIC CORONARY ARTERY CALCIUM SCORING: AN AUTOMATED METHOD

R. Shahzad*,†, T. van Walsum*, M. Schaap*, S. Klein*, L. J. van Vliet†, and W.J. Niessen*,†

*Biomedical Imaging Group Rotterdam, Dept. of Radiology & Medical Informatics,
Erasmus MC, Rotterdam, The Netherlands
†Quantitative Imaging Group Delft, Imaging Science & Technology,
Faculty of Applied Science, TU Delft, Delft, The Netherlands
e-mail: R.Shahzad@tudelft.nl

ABSTRACT

Coronary heart disease is one of the leading causes of death worldwide [1], and coronary artery disease (CAD) is the main cause of coronary heart disease. Therefore, there is much interest in finding biomarkers that could be used for risk stratification and prediction of future events in the patients suspected of CAD [2]. One such biomarker for CAD is the amount of calcium present in the coronary artery plaques, i.e. the calcium score. Whereas risk stratification is currently based on the calcium score for the whole heart, the individual artery calcium score is also of clinical importance, and may be relevant for better diagnosis and therapy planning.

We present an automatic coronary artery specific calcium scoring system for non-contrast enhanced cardiac CT images. Since the coronary arteries are not visible on CT images, our method makes use of patient-specific coronary artery soft masks to detect calcium spots close to the location of the arteries. These masks were computed on contrast enhanced CTA atlas images and then mapped onto the CT image [3]. The information from these masks along with other image features were used to design a pattern recognition classification system that is able to detect calcium within the individual coronary arteries. We report all the commonly used calcium scores (agatston, mass and volume)[4,5,6] for the arteries and the whole heart. The results of the classification system (both, the number of calcification and the total score) are compared to those obtained by manual observers.

REFERENCES

[1] "Cardiovascular diseases (cvds) - fact sheet n317," *World Health Organization*, 2011.

[2] R. Wayhs, A. Zelinger, and P. Raggi, "High coronary artery calcium scores pose an extremely elevated risk for hard events," *J Am Coll Cardiol*, vol. 39, pp. 225–230, 2002.

[3] R. Shahzad, M. Schaap, T. van Walsum, S.Klein, A.C. Weustink, L.J. van Vliet, W. J. Niessen, "A Patient Specific Coronary Artery Density Estimate, " *Proceedings of IEEE International Symposium on Biomedical Imaging: from Nano to Macro,* pp. 9-12, 2010.

[4] AS Agatston, WR Janowitz, FJ Hildner, NR Zusmer, M. Viamonte Jr, and R. Detrano, "Quantification of coronary artery calcium using ultrafast computed tomography," *Journal of the American College of Cardiology*, vol. 15, no. 4, pp. 827, 1990.

[5] T. Callister, B. Cooil, S. Raya, N. Lippolis, D. Russo, and P. Raggi. "Coronary artery disease: improved reproducibility of calcium scoring with an electron beam CT volumetric method", *Radiology*, vol. 208, pp. 807–814, 1998.

[6] Hong C, Becker CR, Schoepf UJ, Ohnesorge B, Bruening R, Reiser MF." Coronary artery calcium: absolute quantification in non-enhanced and contrast-enhanced multi–detector row CT studies". *Radiology,* vol. 223, pp. 474–480, 2002.

Automatic detection of retinal vascular bifurcations by trainable V4-like filters

George Azzopardi and Nicolai Petkov

Johann Bernoulli Institute for Mathematics and Computer Science,
University of Groningen, the Netherlands
e-mail: {g.azzopardi, n.petkov}@rug.nl

We propose a novel method for the detection of vascular bifurcations in retinal fundus images. Our method is implemented in trainable filters that simulate the functions of shape-selective neurons in area V4 of visual cortex. The configuration of such a filter is determined by the automatic analysis of a bifurcation feature that is specified by the user from a training image. In such an analysis, a filter is configured by combining given channels of a bank of Gabor filters, which describe the dominant orientations in the concerned feature, in an AND-gate-like operation. Consequently, the filter can detect the same and similar bifurcation patterns. With only 25 filters we achieved a correct detection rate of 98.52% at a precision rate of 95.19% on a set of 40 binary fundus images available in the DRIVE public dataset. This performance is sufficient for the requirements of the concerned medical application.

Shadow Removal Based on Inpainting and Gradient Manipulation

Bart Liefers, Robby T. Tan

Multimedia and Geometric Group
Department of Information and Computing Sciences
Utrecht University
e-mail: robby@cs.uu.nl

A method for shadow removal based on a gradient manipulation and image inpainting technique is proposed. The method effectively removes variances in color and intensity due to varying illumination. This ability is useful to remove cast shadows, since shadows represent exactly the same variances. Following the algorithm of an existing method, a one-dimensional representation of a shadow-free image is constructed, and used to locate shadow edges. Subsequently, the proposed method employs an inpainting technique in the gradient domain to remove these edges. Integration of the gradient image leads to a new image, similar to the original, but without shadows.

Image Processing in Mathematica 8

Markus van Almsick

Wolfram Research Inc., 100 Trade Center Drive, Champaign, IL 61820-7237, USA
e-mail: markus@wolfram.com

Mathematica is renowned as the world's ultimate application for computations. The talk will illustrate how this bold statement applies to image processing and how the software can be used as a fast prototyping environment and as a fascinating teaching tool. We start with a quick tour through the library of advanced image processing commands, explain their embedding in the comprehensive Mathematica environment, and illustrate the workflow with a few non-trivial image processing examples. We conclude the demonstration with a rapid development of a GPU kernel via Mathematica's CUDA & OpenCL link.

Revenge of the nearest neighbour: Large-scale word retrieval in historic handwritten manuscript collections

Lambert Schomaker

Artificial Intelligence & Cognitive Engineering (ALICE) Faculty of Mathematics and Natural Sciences University of Groningen
e-mail: schomaker@ai.rug.nl

Our work in the area of handwriting recognition has shown that standard (HMM) approaches are too limited to deal with the massive variation in historic handwriting styles. Given the current state of the art, a full PhD project per book would be required. We have focused on methods for allowing text search in large and diverse collections of scans, having a high performance, that can be bootstrapped with just a few examples, as well as being suitable for autonomous, 24/7 machine learning. The resulting system, Monk, can be considered as a revenge of traditional pattern-recognition methods: strong features fed to nearest-neighbour matching using high-performance computing, instead of cumbersome and uncertain machine learning under the supervision of a knowledgeable researcher. The resulting data collection will prove useful to develop a critical mass of training sets with historic styles for more traditional methods (HMM,MLP,SVM) operating at the character level.

An Automated System for Postal Stamp Detection and Recognition

Elena Ranguelova, Jochem van Vroonhoven, Jurrien de Knecht
Research and Development, Prime Vision B.V., Delft, The Netherlands
e-mail: E.Ranguelova@primevision.com

In Prime Vision we have developed a system for automation of postal stamp detection and recognition for the purpose of postal revenue protection. It is a CBIR system consisting of two phases- stamp detection and stamp recognition. In the detection phase, an interest point detector and a rotation-invariant descriptor are applied on the gray image of a mail piece. Subsequent RANSAC matching to a model stamps database produces region of interest and a possible stamp class. The recognition step uses the suggested ROI and verifies or corrects the stamp class by computing color features from a lower resolution color version of the same mail piece image and matches them against the database. The system has been tested on real postal images achieving recognition rates of 97.5% with error of 0.5% and takes about 1s. for matching against a database of 300 stamps.

Hidden-Unit Conditional Random Fields

Laurens van der Maaten (Delft University of Technology),
Max Welling (University of California, Irvine) and
Lawrence Saul (University of California, San Diego)
e-mail: lvdmaaten@gmail.com

The paper explores a generalization of conditional random fields (CRFs) in which binary stochastic hidden units appear between the data and the labels. Hidden-unit CRFs are potentially more powerful than standard CRFs because they can represent nonlinear dependencies at each frame. The hidden units in these models also learn to discover latent distributed structure in the data that improves classification. We derive efficient algorithms for inference and learning in these models by observing that the hidden units are conditionally independent given the data and the labels. Finally, we show that hidden-unit CRFs perform well in experiments on a range of tasks, including optical character recognition, text classification, protein structure prediction, and part-of-speech tagging.

Constrained Parameter Estimation for Semi-Supervised Learning

Marco Loog

Pattern Recognition Laboratory, Delft University of Technology
e-mail: m.loog@tudelft.nl

Semi-supervised learning aims to employ information from both labeled and, more easily obtainable, unlabeled data. Current state-of-the-art semi-supervised learning techniques make additional assumptions about the underlying data in an attempt to exploit such unlabeled data in the training phase. These assumptions, however, typically do not hold true and, as a result, making them can considerably deteriorate classification performance. Our proposal is to develop semi-supervised learning techniques that do not make assumptions beyond those implicitly or explicitly made by the classification scheme employed [c.f. http://dx.doi.org/10.1007/978-3-642-15883-4_19]. The overarching idea to achieve this is to exploit constraints and relations inherent in the parameters of a classifier and / or the data considered. This approach can lead to more efficient parameter estimation and, therefore, learning techniques.

Classification of schizophrenia from structural MRI: Support Vector Machine model evolution

Mireille Nieuwenhuis, UMCU, Psychiatrie
Hugo Schnack, UMCU, Psychiatrie
e-mail: m.nieuwenhuis-4@umcutrecht.nl

Classification of schizophrenia (vs. health) with support vector machines is often done in small groups (on average N=32 per class). Due to this limitation models are not tested on new data, but using Leave One Out. To investigate the impact of group size, we compared the orientation of the optimal separating hyperplanes and sensitivity/specificity percentages. To overcome noisy data, the risk of over fitting and long run-times, we reduced the number of features, selecting those with a bigger influence on the model. Their influence is reflected in the normal vector to the hyperplane. The model was trained on voxels acquisitioned through Voxel Based Morphometry (VBM) from MR images, with group sizes up to N=105 per class, testing was done with N=25 that had not been used in the training phase. From a group size of N=95 the percentages change only moderately. A reduction of 80% improved the runtime with a factor ten. The total outcome improved only 1%.