

Bielefeld University
Faculty of Technology
and Faculty of Physics
Dr. Tim Nattkemper
Dr. Andreas Degenhard

Phone: +49-521-106 6059
Fax: +49-521-106 6011
Email: tnattkem@techfak.uni-bielefeld.de
Email: adegenha@Physik.Uni-Bielefeld.DE

PhD-position available within the *GK Strukturbildungsprozesse*

Detection and Classification of Breast Cancer in Dynamic Magnetic Resonance Imaging Using Morphometric Parameters

Summary of the project: The proposed PhD project is settled in the research field of applied medical physics. It aims to identify and classify breast cancer tissue in Dynamic Contrast Enhanced Magnetic Resonance Imaging (DCEMRI). The work is interdisciplinary and combines concepts from neuro-science, theoretical physics and applied mathematics for processing high resolution magnetic resonance medical imaging data. According to a 3D coverage of the full female breast the processed data are 4D including a time dimension monitoring the uptake of the administered contrast agent in the tissue. In order to evaluate these complex data sets the outlined project description is twofold: In the first period of the project methods for data mining need to be further developed and applied to evaluate morphological and dynamical features. Morphometric parameters will be used to discriminate spatial patterns according to size, shape and connectivity. In a second period an artificial neural network (ANN) classifier will be trained and tested on a symptomatic data set, i.e. a cohort or subset of women with malignant or benign breast lesions all histopathologically classified. In a final step the software should be applied in the clinical evaluation of data to assist the radiologists in their daily work detecting suspicious lesions in the breast, i.e. early detection of breast cancer. It is assumed that in the final stage it is possible to learn from the ANN and to improve on the insight of lesion characterization yielding to modified medical morphometric parameters.

Research field: Artificial Neural Networks (ANN) applied to clinical data evaluation have emerged as powerful tools although, at the same time, undergoing intensive research [1]. Compared to numerous applications in conventional mammography only a few recent studies emphasize their importance within dynamic imaging, i.e. temporal changes according to contrast agent uptake are monitored over time [2, 3]. On the other hand, breast cancer is the most common malignancy in females, constitut-

ing a major health problem in all developed countries [4]. Various studies have shown, that the administration of contrast agent is of clear value in detecting and characterizing breast lesions [6]. Computerized analysis of time dependent data including computer-aided diagnosis is therefore proposed as a future directions in medical research [7]. The idea of this project is therefore to introduce new concepts from computer science and various branches of theoretical physics to accomplish this task [8].

The *Graduiertenkolleg Strukturbildungsprozesse*, located at the University of Bielefeld, Germany, provides an ideal and probably unique framework to accomplish this task and settle the project within the necessary highly interdisciplinary surroundings. Although on the one hand dynamic clinical image data exists in many cancer research centers and on the other hand development of algorithms is advancing in neuro science groups at many technological institutes, concrete collaborations and implementations are very rare. The authors of this proposal are currently not aware of any similar data processing or evaluation project for the detection and classification of breast cancer as it is outlined here. In turn the work in this project will contribute to the active and vivid atmosphere in the Graduiertenkolleg Strukturbildungsprozesse and participation in internal seminars and international workshops and conferences is planned.

Preparatory work: Both supervisors have experience in the field of ANNs applied to medicine and biology. Dr. Tim Nattkemper worked on topological analysis/classification of lymphocytes in tissue sections using microscopy image data [9]. Andreas Degenhard has worked as a postdoctoral scientist at the Institute of Cancer Research in London and was involved in fast Magnetic Resonance Imaging (MRI) for improving the temporal sampling rate [10, 11]. He investigated a first approach of an ANN application for breast screening data, in which data mining was replaced using preevaluated radiological features. This first approach has proved the symptomatic data set to be consistent and details of the performance of the ANN approach have been provided [12]. The applicant will clearly benefit from a well established collaboration with the medical staff at the institute of cancer research London. In addition it is guaranteed by the institute of cancer research London that all necessary clinical data sets are available and will or have been provided already.

Supervision of the project: The project is scheduled for a PhD work, i.e. a time period of three years. On the development site official responsibility is taken by Prof. Dr. Helge Ritter, head of Neuroinformatics Group, University of Bielefeld and Prof. Dr. Philippe Blanchard, Theoretical Physics, University of Bielefeld. Medical assistance and data accessment will be provided by Prof. Dr. Martin O. Leach, head of the Nuclear Magnetic Resonance department at the Institute of Cancer Research in association with the University of London.

References

- [1] Fogel DB, Wasson EC, Boughton EM, Porto VW. *Evolving artificial neural networks for screening features from mammograms*. Radiation Medicine 1997;15:283-293.
- [2] Abdolmaleki P, Buadu LD, Naderimansh H. *Feature extraction and classification of breast cancer on dynamic magnetic resonance imaging using artificial neural network*. Cancer Letters 2001;171:183-191.
- [3] Lucht REA, Knopp MV, Brix G. *Classification of signal-time curves from dynamic MR mammography by neural networks*. Magn Reson Imag 2001;19;51.
- [4] UK MRI Breast Screening Study Advisory Group, Imaging Advisors and Staff *Magnetic resonance imaging screening in women at genetic risk of breast cancer: imaging and analysis protocol for the UK multicentre study*. Magn Reson Imag 2000;18;765.
- [5] Floyd CE, Lo JY, Yun AJ, Sullivan DC, Kornguth PJ. *Prediction of Breast Cancer Malignancy Using an Artificial Neural Network*. Cancer 1994;74;11.
- [6] Heywang-Köbrunner SH, Beck R. *Contrast-Enhanced MRI of the Breast*. Berlin: Springer; 1997.
- [7] Williams MB, Pisano ED, Schnall MD, Fajardo LL. *Future directions in imaging of breast diseases*. Radiology 1998;206;297.
- [8] Beisbart C, Buchert T, Wagner H. *Morphometry of spatial patterns*. Physica A 2001;293;592.
- [9] Nattkemper TW, Ritter HJ, Schubert W. *A Neural Classifier Enabling High-Throughput Topological Analysis of Lymphocytes in Tissue Sections*. IEEE Transactions on Information Technology in Biomedicine 2001;5;138.
- [10] Degenhard A, Tanner C, Hayes C, Hawkes DJ, Leach MO. *Pre-processed image reconstruction applied to breast and brain MR imaging*. Physiological Measurement 2001;22;589.
- [11] Degenhard A, Hayes C, Leach MO. *Consecutive projections onto convex sets*. Physics in Medicine & Biology 2002;47;N61.
- [12] Degenhard A, Tanner C, Hayes C, Hawkes DJ, Leach MO. *Comparison between Radiological and Artificial Neural Network Diagnosis in Clinical Screening*. Accepted for publication in Physiological Measurement 2002 (invited publication).