



June 23–27, 2009  
Berlin, Germany

## CARS 2009

Computer Assisted Radiology and Surgery  
23<sup>rd</sup> International Congress and Exhibition

**Saturday, 27 June, 9:00-12:00**

### Room Paris

#### **09:00 CAD Demo Workshop on Computer-Aided Detection and Diagnosis EFMI WG Medical Image Processing**



##### **Session Chairs:**

Alexander Horsch, PhD (D), Thomas Wittenberg, PhD (D), Vytenis Punys, PhD (LT),  
Matthias Elter, MSc (D)

This workshop consists of live demonstrations of research prototypes of computer aided detection and/or diagnosis systems for medical fields and applications including (but not limited to) mammography, breast MRI, lung CT, colon CT, endoscopy, dermatology, haematology, liver, brain and vascular imaging.

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##### **Computer aided detection of abdominal aortic aneurysms**

J. Dehmeshki, Kingston Univ. (UK)

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##### **A computer-assisted diagnosis system for endoscopic image interpretation**

A. Kage, C. Münzenmeyer, Fraunhofer Inst. für Integrierte Schaltungen, Erlangen (D)

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##### **A Knowledge-based system for the Computer-Aided Diagnosis (CADx) of mammographic lesions**

M. Elter, Fraunhofer Inst. für Integrierte Schaltungen, Erlangen (D)

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##### **CAD for a novel 3-D volumetric whole-breast ultrasound imaging system**

H. Fujita, D. Fukuoka, C. Muramatsu, T. Hara, Gifu Univ. (J)

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##### **The VBNA-CAD system for lung nodule detection in lung CT**

I. Gori, Bracco Imaging SpA, Milan, F. Bagagli, N. Camarlinghi, M.E. Fantacci, A. Retico, Univ. and INFN, Pisa (I)

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##### **CT colonography CAD with sameday fecal tagging**

A. Bert, im3D SpA, Torino (I)

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##### **HemaCAM computer-assisted microscopy for hematology**

D. Steckhan, Fraunhofer Inst. für Integrierte Schaltungen, Erlangen (D)

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##### **CAD scheme for lung nodules detection on helical CT images**

P. Garcia Tahoces, J.J. Suárez Cuenca, M. Souto, M.J. Lado, J.J. Vidal, Univ. of Santiago de Compostela, Univ. of Vigo (E)

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##### **Fully automated 3D segmentation of liver tumors based on Definiens Cognition Network Technology®**

M. Kietzmann, J. Kim, G. Schmidt, G. Binnig, Definiens AG, München (D)

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##### **Identification and assessment of lymph nodes over time with Definiens LymphExpert**

M. Kietzmann, Definiens AG, München (D)

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##### **Image and table analysis for automated detection and diagnosis of breast lesions with Definiens Mammo-iCAD**

R. Schönmeier, P. Elenberg, O. Feehan, G. Schmidt, M. Athellogou, G. Binnig, Definiens AG, München (D)

**12:00 End of Workshop**

## **1 Computer aided detection of abdominal aortic aneurysms**

J. Dehmeshki, Kingston Univ. (UK)

Computer-aided detection (CAD) systems, which automatically detect and indicate location of potential abnormalities in scan digital images, have the capacity to increase the accuracy of the radiologists' interpretations and finding. We have developed an efficient new CAD for automatic and accurate detection and quantification of Abdominal Aortic Aneurysm (AAA). The system first detects and extracts the lumen and then identifies the location of the abdominal aortic from the total lumen. The extracted abdominal aortic lumen is then used as an initial surface to segment the abdominal aorta which might contain aneurysm. The geometrical and morphological features of both lumen and aorta are examined for the presence of aneurysm based on predefined criteria set by incorporating prior understanding of the normal expected variation of aorta. The experimental result of the proposed system on 60 CTA datasets indicated a 98% success in detection (CAD) and a 95% in segmentation results (CAM).

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## **2 A computer-assisted diagnosis system for endoscopic image interpretation**

A. Kage, C. Münzenmayer, Fraunhofer Inst. für Integrierte Schaltungen, Erlangen (D)

The interpretation of endoscopic findings by gastroenterologists is still a difficult and highly subjective task. Despite important developments such as chromoendoscopy, pit pattern analysis, fluorescence imaging as well as narrow band imaging it still requires lots of experience and training with a certain tentativeness until the final biopsy. By the development of computer-assisted diagnosis (CAD) systems this process can be supported. We propose a new approach to CAD for precancerous lesions in the esophagus, namely the diagnosis of Barrett's esophagus based on color-texture analysis in a content-based image retrieval (CBIR) framework. Based on the histological validated ground truth diagnoses of the retrieved lesions, a diagnosis proposal for the unknown query lesion is generated and displayed to the endoscopist. The novelty of our approach lies in the combination of newly developed color-texture features with the interactive feedback loop provided by a relevance feedback algorithm. This allows the expert to steer the query and is still robust against accidental false decisions. In simulations the retrieval accuracy didn't change significantly until a wrong decision rate of 20%. With an initial classification accuracy of about 70% for Barrett's esophagus, the system reaches a performance which is in between the expert and the inexperienced user, who shall be supported by such a system. For the support of the endoscopist during the diagnostic intervention directly at the point of care, the CAD system can be placed directly besides the endoscopy tower. By using a commercially available frame-grabber card, the live image from the endoscopy system can be fed directly into the CAD system. If a gastroscopic image appears on the monitor, depicting possible lesions in the esophagus, cardia or corpus, the operator can easily capture this image into the CAD

system with a foot-switch. The lesion of interest can be easily marked via a touchscreen interface and is analyzed instantaneously.

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### **3 A knowledge-based system for the Computer-Aided Diagnosis (CADx) of mammographic lesions**

M. Elter, Fraunhofer Inst. für Integrierte Schaltungen, Erlangen (D)

We present a research prototype of a knowledge-based system for the computer-aided diagnosis (CADx) of mammographic masses and microcalcifications. The system aims to support the radiologist in the discrimination of benign and malignant types of mammographic lesions. The diagnosis proposal for a lesion is based on a content-based search for similar lesions in a large reference database of lesions with associated ground-truth diagnoses. In addition to the diagnosis proposal and a confidence value, the most similar reference lesions and their diagnoses are presented to the radiologist. This approach makes the decision process of the system transparent to the user. The similarity search can be influenced by the radiologist using a relevance feedback mechanism. The search for similar lesions is based on lesion features that are automatically extracted from a region of interest depicting a lesion. These features are based on automatic segmentations of the lesion from the background tissue.

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### **4 CAD for a novel 3-D volumetric whole-breast ultrasound imaging system**

H. Fujita, D. Fukuoka, C. Muramatsu, T. Hara, Gifu Univ. (J)

Our CAD system is dedicated to breast cancer screening. The detection and classification of breast masses in novel 3-D volumetric whole-breast ultrasound data help to fight breast cancer in young/dense breasts. An image viewer was developed to construct the volumetric breast data. The image viewer features build-in CAD functions that can detect breast mass with a detection rate of 80.6% at 3.8 false positives per breast for breast cancer screening.

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## 5 The VBNA-CAD system for lung nodule detection in lung CT

I. Gori, Bracco Imaging SpA, Milan, F. Bagagli, N. Camarlinghi, M.E. Fantacci, A. Retico, Univ. and INFN, Pisa (I)

We developed a CAD system for pulmonary nodule detection, based on the analysis of low-dose and thin-slice CT images. The system deals differently with internal and juxtapleural nodules, due to their different location and shape. The two dedicated procedures for their identification (CADI for internal and CADJP for juxtapleural nodules) are characterized by three main steps. First of all, a segmentation algorithm identifies the appropriate lung regions for the analysis; then, a 3D dot-enhancement algorithm identifies the nodule candidates for the CADI, whereas a procedure enhancing regions where many pleura surface normals intersect provides the nodule candidates for the CADJP. Finally, an original approach based on a neural classifier working at the voxel level (Voxel-Based Neural Approach - VBNA) reduces the amount of false-positive findings. The <sup>VBNA</sup>CAD system has been demonstrated during the CAD workshop at SPIE Medical Imaging 2009 and showed satisfactory performance in the ANODE09 study. The system was developed in the framework of the Istituto Nazionale di Fisica Nucleare (INFN)- and Ministero dell'Università e della Ricerca (MIUR)-funded MAGIC-5 Italian Collaboration, aiming at developing CAD software systems for Medical Applications.

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## 6 CT colonography CAD with sameday fecal tagging

A. Bert, im3D SpA., Torino (I)

Cleansing designed to work with liquid preparations (based on a locally selected threshold and adaptive intensity-based remapping); CAD-COLON was shown to achieve good performances both with and without FT (RSNA 2008); demo will focus mostly on cleansing and CAD.

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## 7 HemaCAM computer-assisted microscopy for hematology

D. Steckhan, Fraunhofer Inst. für Integrierte Schaltungen, Erlangen (D)

We present a prototype system for the automatic analysis of MGG-stained (May-Giemsa-Grünwald) blood smears. The system automatically analyzes white blood cells (leukocytes) within a blood smear and is able to provide the so called differential white blood cell count (WBC). With the result of the differentiation of the leukocyte cells the system is able to provide a diagnosis proposal (Chronic lymphocytic leukaemia (CML), acute leukaemia, etc.). For this system an automated microscope with two objectives (10x/100x magnification), a digital camera device and a motorized xy-stage is used. In

a first step the system locates the so called valid-area on the slide, where the distribution of the cells fulfils specific criteria necessary for the correct classification of leukocyte cells. In a second step the white blood cells are located in that area using a 10-fold objective. In the third step each cell previously located is analysed with the high magnification objective (100x). The images grabbed in the last step are used for the automatic segmentation and classification of every single cell. For the classification we use a database of cells annotated by several experts and a set of different features. Depending on the classification requirements of the laboratory the system is able to automatically classify in up to 15 subclasses. The final result of the analysis of the slide has to be approved by a hematology expert. Screenshot 1 shows the classification result of one analysed slide with the cells pre-classified by the system. By double-clicking on the cell, the view of each single cell can be magnified to see more details of the cell (Screenshot 2). Screenshot 3 shows a so called virtual-slide view of the analysed slide, where it is possible to have a view on the slide in different magnifications.

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## **8 CAD scheme for lung nodules detection on helical CT images**

P.G. Garcia Tahoces, J.J. Suárez Cuenca, M. Souto, M.J. Lado, J.J. Vidal, Univ. of Santiago de Compostela, Univ. of Vigo (E)

We have developed a computer-aided diagnosis (CAD) system for pulmonary nodules detection. The system analyzes Computer Tomography (CT) images, previously obtained by a CT scanner. The main characteristic of the proposed scheme is the use of a 3D iris filter, specially adapted to the detection of lung nodules. Sphericity of the region also plays an important role for the detection of suspicious regions. The database employed was composed of 7183 CT images from 22 patients, containing 77 pulmonary nodules previously identified by three experienced chest radiologists. Three different types of nodules were employed to build the system: Calcified, isolated, and attached to vessel. Due to the different characteristics of each type of nodule, a complex classifier that combines rule based approach with Linear Discriminant Analysis (LDA) output has been developed to reduce the number of false positives. The system was trained and evaluated by using two independent data sets: Training set composed of 4734 images from 15 patients, and test set composed of 2449 images from 7 patients. Results achieved over the test set demonstrate that, for a sensitivity of 80%, the number of false-positives per scan was 7.7.

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## **9 Fully automated 3D segmentation of liver tumors based on Definiens Cognition Network Technology®**

M. Kietzmann, J. Kim, G. Schmidt, G. Binnig, Definiens AG, München (D)

The reliable detection of liver tumors in CT scans and the precise measurement of their shape is the basis for diagnosis, surgery planning and therapy control of liver cancer. Since manual measurement of 3D structures is extremely time consuming, cost intensive and subjective, automated methods are required in today's challenging clinical environment. Due to a large variability in appearance and shape of liver tumors, the automated reliable segmentation represents a nontrivial task. We describe the application of the Definiens Cognition Network Technology® to a fully automated segmentation of liver tumors. The results are evaluated on a set of six CT scans containing ten tumors using the comparison metrics volumetric overlap, volume difference, average, RMS and maximal surface distance.

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## **10 Identification and assessment of lymph nodes over time with Definiens LymphExpert**

M. Kietzmann, Definiens AG, München (D)

Definiens LymphExpert helps radiologists to identify, analyze and measure the size of lymph nodes over time, making it easier to detect the metastatic spread of cancer. Accurate early detection means that treatment can be more effectively targeted, reducing costs and promoting better outcomes for patients. Definiens LymphExpert facilitates the manual detection of lymph nodes in a CT image. Once a radiologist identifies a lymph node, the application automatically segments the node and analyzes its properties. It quantifies the lymph node according to RECIST and WHO guidelines as well as visualizes its volume. Definiens LymphExpert results are accurate, fast and reproducible, supporting the physicians who make decisions about the most effective course of therapy.

Contact: (see demo 9)

## **11 Image and table analysis for automated detection and diagnosis of breast lesions within the Mammo-iCAD research project**

R. Schönmeier, P. Ellenberg, O. Feehan, G. Schmidt, M. Athellogou, G. Binnig, Definiens AG, München (D)

Mammo-iCAD is a research project, which is funded by the Bavarian Research Administration. A prototype for Case Based Reasoning (CBR) – Computer Aided Diagnosis (CAD) System for mammography data was developed in accordance to project objectives. Based on the Definiens Cognition Network Technology® the system contains software components for the integration of data from different data structures and from different data modalities and employs its own annotated reference database. A unique strength of the system is its ability to use and combine contents from different data structures such as images, text, tables and demographic data in a flexible way. Accordingly the system provides a holistic, comprehensive and multimodal method for a new generation of CBR-CAD

Systems. The prototype includes components for automated object based segmentation and detection of suspicious mass lesions in mammography images. Object properties are automatically stored in a data-base along with breast-view information and patient meta-data to allow for additional extraction of meaningful context-based features. A user interface enables the user to define a search case interactively. The system searches the reference data-base for similar cases and suggests a diagnosis based upon ranked results.

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