LIFE SCIENCES VIEWING ROOM

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Abstract: A radiological picture archiving and communication system (PACS) has been installed at the department of Biomedical Engineering of TU/e for student and researchers use. The availability of large sets of high resolution 3D image data sets, and the extensive interactive 3D manipulation possibilities, turn out to be an important support and stimulation for the students in their projects. The system can be considered an ultimate interactive 3D anatomy book.

1 INTRODUCTION

Medical images play a crucial role in the diagnostic process. It is estimated that 80% of all diagnoses are done based on images. They are made in huge numbers, with a wide variety of medical imaging devices, such as X-ray systems, CT and MRI scanners, ultrasound systems, PET scanners, etc. Almost every modern hospital is now equipped with a medical image database, accessible from a large number of places throughout the hospital. Such a system is called 'Picture Archiving and Communication System' (PACS) (Huang 2010). Typically it contains several tens of terabytes of information, and has now fully replaced the film-based archive and viewing.

Viewing (also called 'reading') of the images, in order to do the diagnosis, and comparing the current exam with previous ones, is typically done in a 'reading room' (figure 1), on a PACS viewing system. Such a system is not only capable of browsing quickly in the database and retrieve the image data, but also has a wide range of additional functions, such as interactive 3D viewing, slicing of 3D data in any direction, automated detection of anomalies such as polyps, narrowed bloodvessels (stenosis), diminished perfusion, etc. (Beutel et al. 2000]. Modern medical image analysis software is able to perform these tasks (ter Haar Romeny 2007, Fitzpatrick 2009). The field of 'computer-aided detection and diagnosis' is rapidly evolving. PACS

has a positive influence on the education of radiologists in training (Mullins et al. 2001). At technical universities, where students are trained to become a specialist / engineer in medical image analysis, such valuable patient datasets are often not available, or only in limited numbers and types.

Figure 1: Reading room at a radiology department.

We installed a PACS for student use at the Biomedical Engineering Department of Eindhoven University of Technology, the Netherlands. This system contains an exhaustively complete set of anonymized high resolution 2D and 3D medical imaging datasets of a wide range of modalities, primarily of normal subjects. The system has a fast GPU based 3D viewing mode for huge datasets. As such, it forms a rather unique, fully interactive anatomy book.

2 LIFE SCIENCES VIEWING ROOM

The acquisition of two PACS workstations from the company Rogan Delft is made possible by a generous gift of the Eindhoven University Fund (UFE). These two workstations, communicating over a gigabit network with a 1 TB server-side database, are set up in the so called *Life Sciences Viewing Room*, which is given a prominent place in the department. Both workstations consist of a powerful pc with 4 GB RAM and an NVidia GTX 8800 graphics card (GPU). The data can be viewed using three professional Eizo medical displays: two Radiforce G22 monitors (black-and-white, 10 bit colordepth, 2 megapixel) and one Radiforce R22 color display.

Figure 2: 3D view of the carotid arteries with severe stenosis. CT data. Courtesy: 3mensio Inc.

The high graphical performance of the workstations allows software like *3viseon* by the Dutch company 3mensio Medical Imaging BV to render astounding volumes in real time on the GPU (Figure 2). This adds a very special dimension to the system. The students can interactively inspect any anatomical part of the body, be it from CT or MRI data, zoom, rotate, cut away views, fly through intestines or blood vessels, do measurements, and act just like a professional radiologist during his careful inspection of the data. The system is also equipped with extra software for grabbing movies of any screen action, enabling the student to make promotional material for his project presentation, or show these proudly at home.

The two systems are located in the experimental lab of the department, and are fulltime accessible. For one of the systems a dedicated room is constructed with dimmable lighting, and theatre sitting for 16 people, for discussions and presentations.

The medical 2D and 3D datasets are collected from collaborating hospitals and industry, and from general accessible databases on the internet,. The system may currently be one of the most complete interactive anatomy books around. The available data are mostly of normals, with some pathology. This serves the purpose of general viewing for the students. If a project is done on e.g. heart valves, these can be studied interactively and in full detail in 3D on the system. Next to medical data the system is now filled with images from the life sciences—the reason why the facility is calles *Life Sciences Viewing Room*—such as microscopy from a wide range of microscopes available in the Biomedical Engineering Department (conventional light, confocal, and 2-photon scanned laser microscopes), and high field (6-9 Tesla) small bore MRI systems for small animal imaging.

Two student assistants are appointed to fill the system with relevant high resolution, high quality data. The system now has a rather complete set of anatomical areas, with many modalities, and is growing. About 250 datasets are currently available. The book Gray's Anatomy is located on the user's desk for reference. The graphical user interface (GUI, Figure 4) of the system is designed by these assistants, enabling a first graphical selection on anatomical region, then modality, then a specific patient, and finally a specific dataset of that patient. All data are in the standard DICOM format (DICOM – Digital Imaging and Communications in Medicine, a universal standard adopted by the medical imaging industry and community), and have been carefully anonymized. To further prevent any chance of recognizing the face of a patient, We exchange data with a similar database in our sister BMIE School in Shenyang, China. There, the 3D viewing and manipulation software is based on the PACS viewer of Neusoft Inc.

Figure 3: Students active with the casus to analyse microscopy images of blood cells for pathology.

3 ROLE IN EDUCATION

The system can be accessed at all times by all students. It is however also part of the regular curriculum. Two courses exploit the new interactive viewing capabilities. During the so-called Skills-Labs, at the end of the last year of the Bachelor curriculum, the students have to generate demonstration movies of 3D manipulation of a specific and specified anatomical region, answering specific question about the 3D anatomy such as 'where exactly is the polyp located', 'what is the shortest distance of the kidney surface to the skin', 'what is the diameter of the carotid artery just above the bifurcation'. Students work in pairs during these labs.

A second course is a so-called casus, a first-year BSc project of six weeks for groups of eight students (Figure 3), entitled *Image Processing for Pathology*. In this casus students build an automated system to assist the pathologist to analyze cells from microscopy images. They need to 'find the sick cells among the healthy ones'. They are free in the selection of the type of disease, type of images, and task to solve. An interesting spirit of competition emerges between the typically 8-10 groups of students simultaneously active. The cell analysis software is developed in Wolfram's Mathematica 7.

The Life Sciences Viewing Room facility is used to view and inspect the data, and to run a dedicated program (Huygens, by SVI Inc.) to sharpen the microscopy images by deconvolution. The actual working and experimenting with this program gives
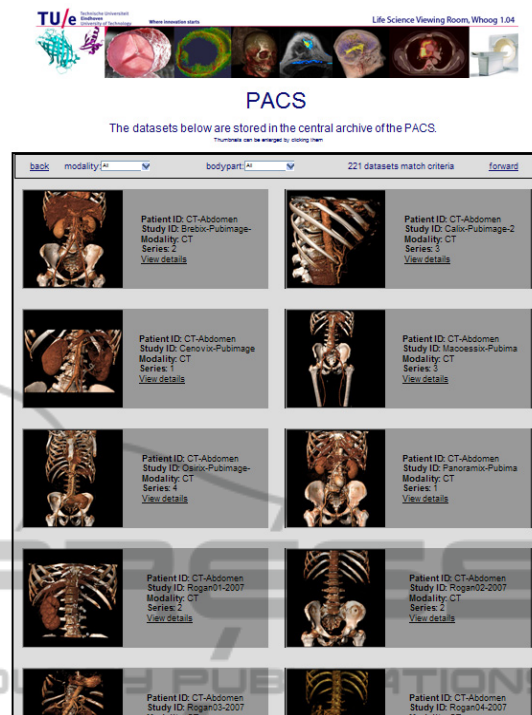

Figure 4: User interface with thumbnails to quickly select a particular 3D dataset.

them a much better understanding of the underlying theoretical principles of deconvolution, which are non-trivial for most students.

In our sister BMIE school in Shenyang, China, we have set up a new curriculum with emphasis on Design Centered learning. We foresee that their copy of the Life Sciences Viewing Room will enable the same 'explorative urge' of the students, and facilitate the use of extended datasets in current projects of research on image analysis and visualization.

4 DISCUSSION

The system is much appreciated by the students. Besides the already developed virtual anatomy book, the ambition is to have the Life Sciences Viewing Room grown into a pivot of biomedical images for the faculty, containing images from all research areas in the department, which can be used for various educational goals. It also turns out to have an attractive role in demonstrations of the current status in biomedical imaging, for visiting parents and new employees alike.

This system is easy to build, and might benefit of joining a network of users, who each supply new

and additional datasets in a shared database to each other. For patient security, care should be taken to properly anonymize all data, to prevent any chance of recognition. Students appreciate the 'playing with data', are introduced to the many sophisticated viewing applications, and embrace it as an exciting new tool for fast and visual image manipulation and analysis, be it for medical or life sciences data.

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