KHRESMOI FOR RADIOLOGISTS

VISUAL SEARCH IN RADIOLOGY ARCHIVES AND THE OPEN-ACCESS MEDICAL LITERATURE

Introduction

Radiology is a field strongly linked to medical imaging. The size of visual data being produced in hospitals increases exponentially, and new imaging techniques are being introduced regularly. An EU report estimated medical imaging to occupy 30% of world storage in 2010 (High Level Expert Group 2010). However, after being used once for diagnosis, typically this enormous amount of visual information in hospitals remains unexploited. Recent studies have shown that, even though visual information search is a task performed daily, radiologists fail to find relevant images one out of four times using existing solutions (Markonis et al. 2012). Access to electronic records is often solely patient-based, while image search on the Internet is mostly performed using general-purpose search engines that return results of questionable quality.

The KHRESMOI Project

“Knowledge Helper for Medical and Other Information users” (KHRESMOI) is a four-year European project funded since 2010 in the 7th Framework Programme, consisting of 12 partners from academia and industry that originate from 9 European countries. KHRESMOI aims to create a multi-lingual, multi-modal search and access system for biomedical information and documents. Radiologists are among the three target user groups of the project (see Figure 1), as they often search for images during their clinical work, teaching duties and research activities. The system uses tools that exploit state-of-the-art techniques in information retrieval to assist radiologists in demanding information need scenarios. The two other user groups of patients and general practitioners concentrate rather on text and semantic search and prototypes have been developed for these groups. This article details the radiology search system.

User-Oriented Design

A user-oriented approach was followed to develop and evaluate the entire system. Following a user-centred design the system is more likely to correspond to realistic requirements of the target user groups. Observation of the radiology clinical workflow and interviews with radiologists assisted in identifying the information needs of radiologists and creating the portrait of an ideal system (Markonis et al. 2012). The development was performed in an iterative manner, having radiologists test the prototypes (Markonis et al. 2013), and modifying the system according to the feedback from the user tests. Currently, a new version of user tests is being prepared for obtaining additional feedback before the final prototypes are implemented.

Content-Based Image Retrieval

In clinical work in radiology, such as differential diagnosis or when an unknown abnormality is found in an image, search by keywords for finding answers to an unknown visual finding is not the optimal or even an applicable solution. Being able to mark a region of interest in an image can be much more efficient and effective than comparing an image on screen with images printed in books. Apart from conventional text-based search, the KHRESMOI system makes use of content-based image retrieval (CBIR) to address these common yet often unaddressed scenarios. CBIR is an information retrieval technique that allows querying by using an image example or image regions to retrieve visually similar results without the need of text. In some cases images are combined with text to leverage additional information available at query time. CBIR has been proposed as a promising field in medical applications (Müller et al. 2004; Aisen et al. 2003), but only a few applications have yet reached the clinical environment. Many of the problems are linked to low retrieval performance when only visual information is used and the combination of text with visual attributes seems most promising. Figure 1, an example screenshot of an application developed in KHRESMOI can be seen.

Search in Hospital Imaging Databases

The KHRESMOI system allows for CBIR search in databases of radiology reports and imaging data such as magnetic resonance imaging (MRI) or computed tomography (CT) volumes (see Figure 3). A typical user assesses an individual case by analysing the imaging data (e.g., a lung CT) and uses basic image manipulation to improve visualisation (zoom, level window settings). If an unknown abnormality is found, he/she can mark a region of interest (ROI) and initiate a search. The system will automatically extract visual characteristics of the ROI and search the database for volumes of the same anatomic location that contain ROIs with similar visual features. The results are returned in the form of a ranked list, and the user can select individual result cases to be displayed in full size. In these cases ROIs that are similar to the query are highlighted in the images.

The radiology reports associated with the volumes are also available. Radlex terms (Langloix 2006) relating to anatomical regions, pathological observations and other aspects mentioned in the report are highlighted, while filtering of the results by Radlex terms is supported to focus search results. Finally, the system automatically analyses the top ranked results to find

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Figure 1. Overview of the Kresmoi system that indexes large amounts of multilingual and multimodal medical data for better information retrieval applications.
diagnosis groupings relevant for differential diagnosis. The proposed diagnoses are then shown in decreasing order with the goal to help differential diagnosis. The physician is still taking decisions and creating the radiology report, but the system provides the expert with relevant information and possible pointers for difficult-to-diagnose abnormalities. The search can be extended to the open access medical literature using as queries the diagnosis terms and slices of interest. Again, visual information and textual data is used to provide specificity during an extended content-based information query.

The primary objective of the system is to provide radiologists with efficient access to information in the hospital image storage system (PACS) together with corresponding reports when preparing a new radiology report. This allows use of the knowledge of other physicians who described similar cases in the past. The system was demonstrated on a collection of 3876 volumes of CTs and MRIs extracted from the PACS of the General Hospital Vienna, and scalability has been taken into account in order to be able to handle larger datasets that occur in all big hospitals.

Assessing Images from the Open Access Medical Literature

The biomedical literature contains a large amount of academically interesting or rare cases. Apart from the obvious uses in teaching and research activities this information can also be used in differential diagnosis. The KHRESMOI system allows image search into the open access medical literature and straightforward connection with the corresponding articles (see Figure 2).

A search may be initiated by keywords and/or image examples or as a succession of the search in the internal hospital PACS described in the previous section. Filtering results by specifying the imaging modality is available, while a number of images in the result list can be marked as relevant or non relevant to quickly reformatulate the query and obtain better results. Images can be selected from the results view to help differential diagnosis. The physician then shown in decreasing order with the goal to help differential diagnosis. The physician is still taking decisions and creating the radiology report, but the system provides the expert with relevant information and possible pointers for difficult-to-diagnose abnormalities. The search can be extended to the open access medical literature using as queries the diagnosis terms and slices of interest. Again, visual information and textual data is used to provide specificity during an extended content-based information query.

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