

# A Visual Information Retrieval System for Radiology Reports and the Medical Literature

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**Abstract.** The enormous amount of visual data in Picture Archival and Communication Systems (PACS) and in the medical literature is growing exponentially. In the proposed demo, the medical image search of the KHRESMOI project is presented to solve some of the challenges of medical data management and retrieval. The system allows searching for visual information by combining content-based image retrieval (CBIR) and text retrieval in several languages using semantic concepts. 3D visual retrieval in internal hospital sources is supported by marking volumes of interest (VOI) in the data and connection to the medical literature are established to allow further investigating interesting cases. The system is demonstrated on 5TB of radiology reports with associated images and articles of the biomedical literature with over 1.7M images.

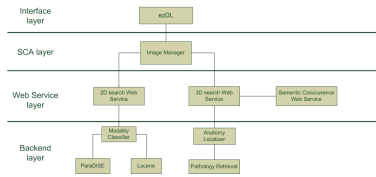
## 1 Introduction

Search for visual information is a common task in the radiology workflow, clinical work, teaching and research activities. Recent studies have shown that radiologists often fail when searching for images using the current information retrieval tools such as Google [1]. Search in hospital records is mostly patient-based, while external sources are often accessed by general search engines that return information of questionable quality. Conventional search by keywords cannot fully cope with all medical tasks, such as for differential diagnosis or in cases where a pattern found is not known. CBIR has been promising in medical applications [2]. However, few applications have reached the clinicians [3] as they were mostly technology driven. User-oriented design [4] has been proposed for creating applications with a real impact in medical information search.

The KHRESMOI project<sup>4</sup> aims at creating a multi-modal search system for biomedical information. One of the target user groups are radiologists and their tasks are strongly related to visual information search. Text-based search and CBIR in hospital databases and in the biomedical literature are supported (see Fig. 1 for an overview of the system). The development of the system followed

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<sup>4</sup> <http://khresmoi.eu/>



**Fig. 1.** Overview of the system architecture.

a user-centered approach. First, investigation of the image search behavior of radiologists [1] was conducted, followed by user tests on the first version of the system [5]. The resulting prototype is presented in this paper and will be demonstrated at the conference.

## 2 Clinical Radiology 3D Image Search

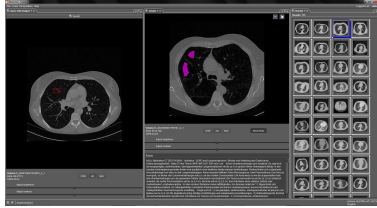
The 3D image search is aimed at supporting clinical radiologists during the assessment of radiology data. To query, the radiologist marks a region of interest in the imaging data of a case under assessment. The system then searches for similar image content in a large data base of radiological imaging data. The search result consists of a ranked list of cases, each with markers for regions that have appearance similar to the query region. For each case the radiology report is displayed, and terms relating to anatomical regions, and pathological observations in the image are highlighted.

During indexing, the prototype uses a fragment registration based localization engine to map anatomy labels to each volume [6, 7]. Then feature vocabularies are built for each anatomical structure [8]. They form the basis for anatomy specific pathology retrieval. Finally indices are built for individual anatomical structures. During a query, first, the anatomy label of the query region is identified, then closest neighbors in the corresponding index are found, and displayed.

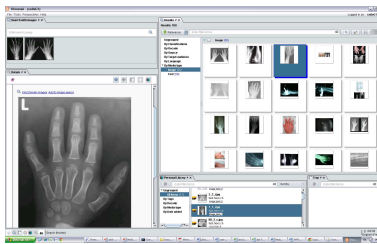
The retrieval process is based on interviews with clinical radiologists, and aimed at fitting well into their workflow. The primary objective is to provide radiologists with efficient access to information in the hospital image storage (PACS) together with corresponding reports even before they make a diagnosis, or specify an observation.

## 3 2D Medical Document Image Search

In this section, the features, the architecture and the methods used for accessing the images and articles in the medical literature are described. The frontend is based on the ezDL interface [9] but in principle any other type of interface can be used. The system allows querying by keywords and/or image examples and returns a list of images or articles (Fig. 3). Images can be viewed in full size



**Fig. 2.** Screenshot of the 3D search prototype. A query image is displayed on the left. A VOI can be marked and a result list is displayed on the right. Details can be viewed in the middle along with the volumes matching the VOI. Below is the radiology report.



**Fig. 3.** Screenshot of the 2D search prototype. Main tools are the Query zone (top left) to supply keywords and/or image examples as queries, the result list (top right) to inspect results and the details view (bottom left) to view details of selected results.

along with information such as the caption and corresponding articles. Filtering results by specific imaging modality is supported, as well as using relevance feedback.

The architecture uses RESTful web services for distributing the services and allowing easy connections. The text search is based on Lucene<sup>5</sup>. The visual search uses the Parallel Distributed Image Search Engine (ParaDISE) [10]. ParaDISE uses the Hadoop implementation [11] of the MapReduce framework for parallelizing the indexing of the visual features. The plug-in like design allows easy addition of features and indexing techniques. Like this updates of the system with novel image retrieval methods are easy.

The prototype will be demonstrated on PubmedCentral data containing 1.7M images of 700'000 biomedical articles. For modeling the content of images for CBIR, the features Bag-of-Visual-Words (BoVW) and Bag-of-Colors (BoC), evaluated in [10], were used. Efficient online retrieval was obtained using locality sensitive hashing (E2LSH) [12] for approximate nearest neighbour search.

<sup>5</sup> <http://lucene.apache.org/>

## 4 Conclusions

New decision support tools are required to assist radiologists in their daily work and help them cope with the increasing amount of data that they need to analyze daily. Medical CBIR is a promising technique that can be used for a large variety of scenarios from keyword search to visual search of full images and regions or volumes of interest. The demo will show the combination of visual search with text search, the mix connection between the 2D and 3D search functionalities but also the possibilities of an adaptive user interface and other functionalities such as translation of found texts, spelling corrections and links of the keywords to standard terminologies.

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