Khresmoi Professional: Multilingual, Multimodal Professional Medical Search

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ABSTRACT

There is increasing interest in and need for innovative solutions to medical search within both the academic and industry communities. In this demo paper we present the EU funded Khresmoi medical search and access system, currently in year 3 of 4 of development across 12 institutions comprising research centers, technology industries and medical organizations. The developed system uses a component based architecture housed in the cloud to allow for the development of several innovative applications to support target users medical information needs. This includes web systems, computer applications and mobile applications to support the multilingual and multimodal information needs of three test target groups, namely the general public, medical doctors and radiologists. In this demo paper we focus on the presentation of the innovative systems generated to support medical doctors and radiologists multilingual text and image based (including 2D and 3D radiology images) search and information needs.

Categories and Subject Descriptors

J.3 [LIFE AND MEDICAL SCIENCES]: Medical information systems

Keywords

Multilingual, multimodal, medical search system

1.   INTRODUCTION

The Khresmoi project[1] is developing a multilingual multimodal search and access system for medical and health information and documents. It addresses the challenges of searching through huge amounts of medical data, including general medical information available on the internet, as well as 2D and 3D radiology images in hospital archives. The system allows text querying in several languages, in combination with image queries. Extensive medical knowledge bases support semantic search. Results can be translated using a machine translation tool specifically trained on medical text.

The system is aimed at three main end user groups: members of the general public, medical doctors and radiologists (a group of

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[1] http://khresmoi.eu/

clinicians for which image search is of immense importance). An outline of the Khresmoi concept is shown in Figure 1. In this demo paper we focus on the innovative functionality of the medical practitioner and radiologists search applications.
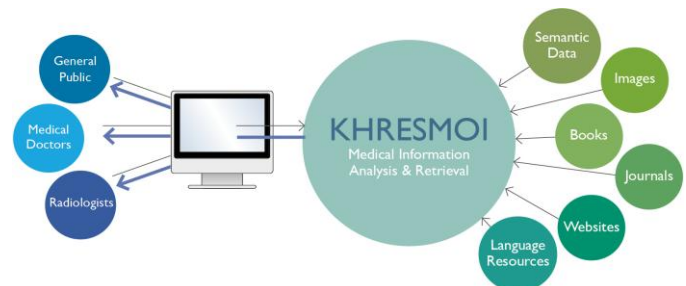

Figure 1 - The Khresmoi Concept

2.   INNOVATIVE MEDICAL SEARCH SYSTEM

The backend technology driving the Khresmoi applications has been developed using a components based architecture supported by a cloud infrastructure [7]. Components in this system include search component, knowledge-base component, machine translation component, query disambiguation component, spell-checking component, etc. This modular integration of multiple software technologies in the system architecture allows for easy development of required medical search applications, such as the doctors and radiologists applications described in this paper. These applications are innovative in several ways, including:

- Multimodal search system for medical practitioners, offering multilingual support, faceted search, and several personal support components including facilities to save items and collaborate with peers.

- Large-scale image search based on visual similarity of images, supporting both 2D images (X-rays and images in publications) and 3D images (CT and MR).

These systems were developed in a holistic way, taking into consideration users needs and requirements as determined by extensive questionnaires and analysis conducted within the Khresmoi project [3, 5]. Rounds of user-centered evaluations at both the interface component and interface system level were, and continue to be, used for iterative system improvement [1, 2, 4]. These system level evaluations use medical practitioners and

radiologists performing realistic tasks, to develop systems which function for the target users in ways most useful for them.

In addition to this, the backend system components are empirically evaluated using the Khresmoi document and image collection and generated test collections representing real users' information needs and querying behaviors. As part of this analysis a novel global empirical evaluation is being conducted to measure the impact of components of the system on each other, and importantly how the performance of these components in isolation and unison impact on the information displayed to users and on end user experience [6].

The next sections take a more detailed look at the innovative functionalities of the practitioners and radiologists prototypes.
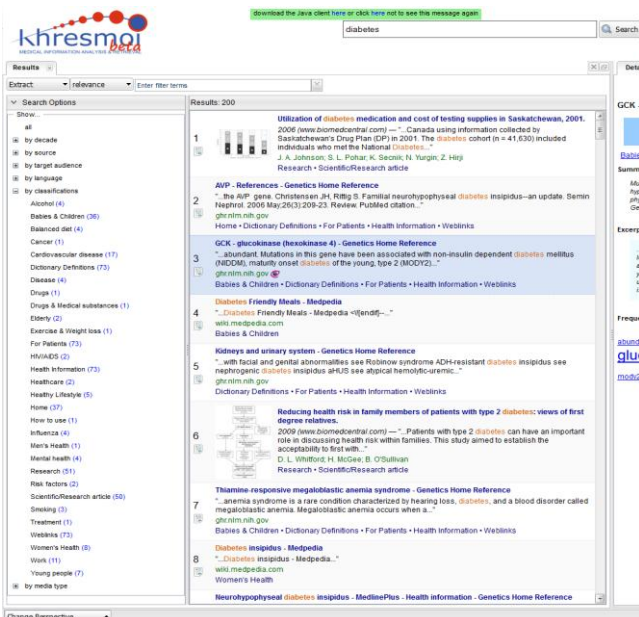

Figure 2: The web frontend

3.   MEDICAL SEARCH FOR PRACTITIONERS

The Khresmoi search prototype for practitioners combines technologies developed within the Khresmoi project into an integrated platform. It currently provides two user interfaces. One is a browser based web application[2] written in GWT while the other is a Java Swing desktop application[3]. Both share a common backend service infrastructure also written in Java. A third user interface for Android devices is currently under development.

Crawled websites with trustworthy medical information targeted at practitioners are semantically annotated using GATE technology[4] and then indexed by Mimir[5]. In addition, images from medical publications are also indexed (using ParaDISE[6]).
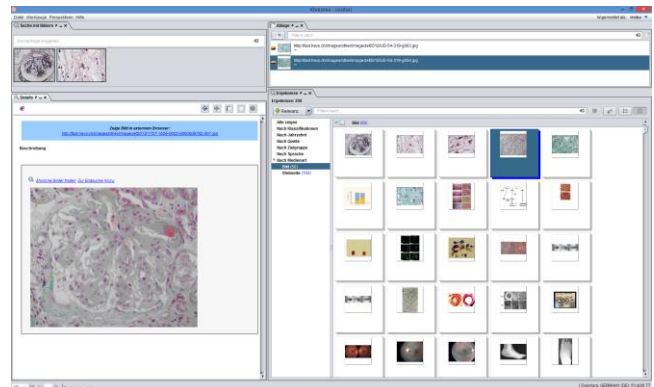
Figure 3: Swing frontend - image search functionality for medical practitioners

The web frontend (see Figure 2) features basic functionality like running text-based searches, filtering and sorting of result sets. It also includes a so called facet explorer, a means to quickly filter the result set by certain meta data attributes. The system gives spelling corrections and disambiguation suggestions while a user is typing a query. Result sets may include images which can be used to trigger searches for visually similar images.

Users can store retrieved documents in a tray for later inspection. The personal library is a permanent storage for documents of various formats and is available to all registered users. Queries are recorded and can easily be reissued by utilizing a separate view in the interface.

The interface consists of several components each containing an aspect of the systems functionality which are arranged in predefined layouts suitable for the most common tasks. All components can be (un-)hidden from the perspective, re-sized and moved in the interface.

The Swing interface includes all features of the web prototype. Furthermore, users can issue an image search by dropping an image from their file system or browser in a special search box (see Figure 3). In addition, the desktop client has collaborative features. Registered users can share found documents with other users or user groups. For scientific work import and export of document Bibtex records is supported.

Both interfaces are fully internationalised for all Khresmoi project languages, including English, German, French, Spanish and Czech, as well as for Chinese and Vietnamese.

Based on the Swing version of the interface the prototype for radiologists was created. It shares the same technological basis and is described in the next section.

4.   MEDICAL SEARCH FOR RADIOLOGISTS

Figure 4 - Khresmoi interface for radiologists

Similar to the Khresmoi search for medical professionals, the Khresmoi search system for radiologists combines technologies developed within the Khresmoi project into an integrated platform. This system is for use by radiologists in medical institutions, allowing for the search and comparison of 2D and 3D radiology images. Given the sensitive nature of the medical imagining data of patients, the system is not publicly available. However, a demo can be viewed[7].

Figure 4 presents the interface instantiated for use by radiologists (also noticeable by the colour scheme adapted to the radiology requirements). Note that this is the same interface framework shown in Figure 2, but with different tools visible. Here the query is the selected area of the image slice shown in the left panel. The images in the panel on the right are returned based on their visual similarity to the region marked in the query. In the central panel, the selected image is shown, along with the associated radiology report. For this application, only the images stored in the archives of the hospital in which the system is used are indexed. However, the possibility to do a visual search of 2D images from the medical literature is also provided.

A use case for this system is that a radiologist faced with an unusual or unknown structure in an image can query the hospital archives for images containing a similar structure, and use the (anonymised) radiology reports associated with these images to guide the reading of the image.

5.   ACKNOWLEDGEMENTS

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