Grant Agreement Number: 257528

KHRESMOI
www.khresmoi.eu

Public annual report 4

Deliverable number	*D13.3.4*
Dissemination level	*Public*
Delivery date	*20 November 2013*
Status	*Review*
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1   Khresmoi Annual Report

http://khresmoi.eu

The Khresmoi project addresses the challenges of searching through large amounts of radiology data, including Magnetic Resonance (MR) and Computed Tomography (CT), in hospital archives, as well as general medical information available on the Internet. For the latter, it addresses the issues of trustworthiness and readability levels. The project consortium, consisting of 12 partners from 9 European countries, develops a multilingual multimodal search and access system for biomedical information and documents. The system allows text querying in several languages, in combination with image queries. It returns translated document summaries linked to the original documents. Khresmoi started on the 1st of September 2010 and runs for four years.

2   Summary of Activities

In its third year, the main achievement of Khresmoi was the creation of an integrated prototype with three "faces," with each face aimed at one of the three main groups of end users: members of the general public, physicians in general, and radiologists, the group of physicians having particular interest in working with images. Beyond creating the prototypes, they were also evaluated in a user-centred evaluation with representative members of the end user groups. Finally, a meta-analysis of all evaluation activities was performed to get an overview of the overall performance of technologies developed in Khresmoi.

3   Khresmoi Prototype

The Khresmoi prototype integrates all technology developed in Khresmoi. The prototype now runs on the Khresmoi Cloud, a private cloud made up of nine servers with one Terabyte of RAM and 28 Terabytes of storage, leading to better performance of the prototype and higher reliability.

The Khresmoi prototype was clearly divided into three *faces*, with each face meeting the requirements of one of the target groups of end users. The three faces are:
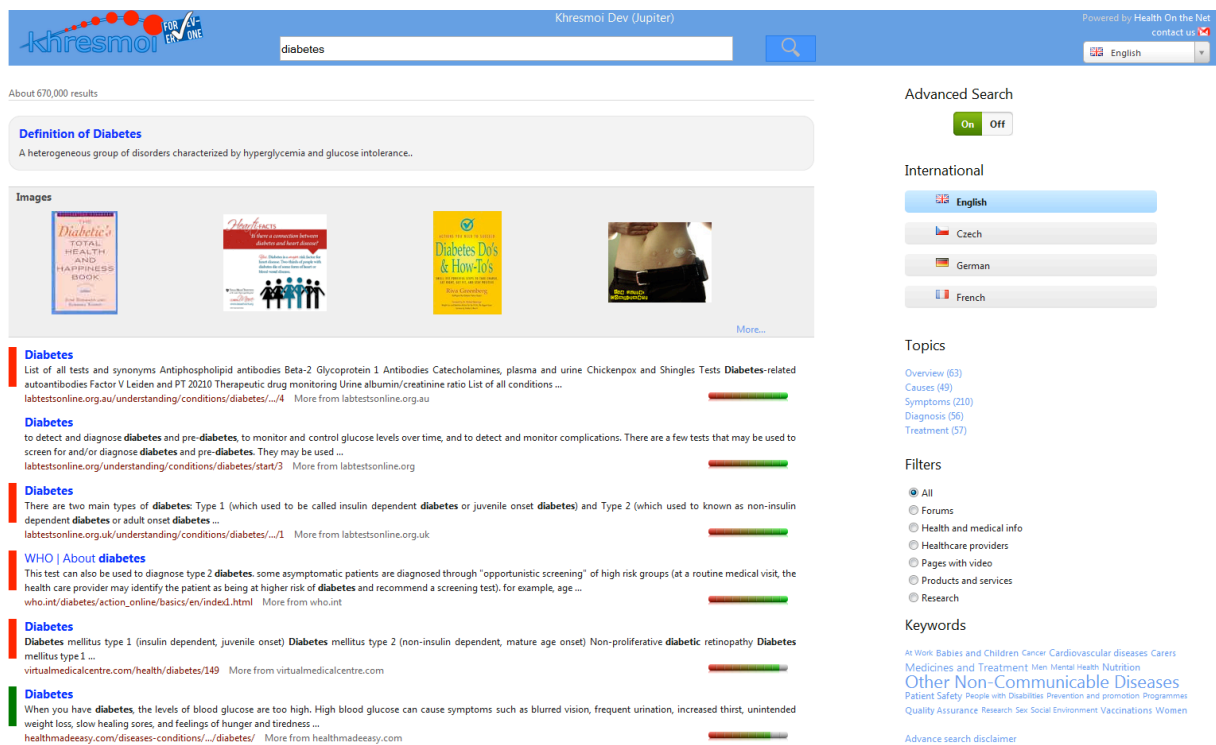
- **Khresmoi for Everyone:** This face presents a straightforward search interface aimed at members of the general public. It also has features specific to the medical domain developed in Khresmoi, such as medicine-specific machine translation and automated estimated of the trustability and readability levels of documents. This face is shown in Figure 1. The red or green bar to the left of each result in the result list indicates the estimated readability level, while the scale to the right of each result

presents the estimated trustability level of the website. Translation and filtering options are available on the right of the window.

- **Khresmoi Professional:** This face, shown in Figure 2, is aimed at medical professionals. The interface is more comprehensive, and allows results to be stored in a personal library, rated and shared with colleagues. Support for medicine-specific machine translation and image search based on visual similarity are also available. Various facets classifying the results are shown on the left of the window.

- **Khresmoi Radiology:** This face, shown in Figure 3, makes available the advanced visual search capabilities required by radiologists. It allows search by visual similarity through 3D images (CT, MRI, …) stored in a hospital PACS, as well as through 2D images in the medical literature. A region of an image can be chosen (on the left in Figure 3), and the system will present the most similar images from the PACS (on the right in Figure 3). Search results and associated radiology reports can be viewed. Analyses of the texts in the radiology reports accompanying the search results allow the most commonly mentioned pathologies in the radiology reports to be identified.

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Figure 1: Khresmoi for Everyone

Figure 2: Khresmoi Professional

Figure 3: Khresmoi Radiology

4 Khresmoi Technology

The software that Khresmoi is built upon has undergone significant advancement through work in Khresmoi. The software is listed below, along with the advances achieved in Khresmoi:

- **GATE** (https://gate.ac.uk/): The General Architecture for Text Engineering (GATE) is used to annotate at word, section and document levels. Through work in Khresmoi, its capabilities for annotating medical documents have been expanded. The use of cycles of human correction to improve the automatic annotation has also been extensively tested.

- **Mimir** (https://gate.ac.uk/mimir/) uses GATE annotations to perform semantic search. The Khresmoi Mimir Interface (KMI) has been developed to allow more user friendly querying of Mimir from Khresmoi. A semantic typeahead service and corresponding interface have also been developed to allow straightforward semantic querying.

- **ezDL** (http://ezdl.de/) is a framework for interactive search applications. New features have been added, including drop down options for query specification, and automatic translation of non-English query terms if too few results are returned. It has also been made more stable and efficient. Two front-ends are now available for ezDL: the original Java Swing interface and a new web interface.

- **ParaDISE** is a new visual search engine developed in Khresmoi as a successor to the GNU Image Finding Tool (GIFT). It is more scalable than GIFT and contains state-of-the-art image features and visual similarity calculation.

- The **MOSES** statistical machine translation software (http://www.statmt.org/moses/) has been further adapted to machine translation in the medical domain by extensive training on domain-specific texts in English, German, French and Czech. For texts in the medical domain, experiments have shown that the translation results are now better than those obtained using Google or Bing translation services.

- The **OWLIM** semantic repository (http://www.ontotext.com/owlim) has received performance and functionality upgrades, and has also had its medical knowledge base expanded through the addition of new medical vocabularies and new links between the medical vocabularies.

5 Evaluation

The three faces of Khresmoi were evaluated in user-centered evaluations for all three end user groups targeted by Khresmoi. Specifically, they were performed by 28 members of the general public, 19 physicians and 17 radiologists. The evaluations for all three user groups involved the users carrying out well-defined search tasks on the appropriate prototype, while a large amount of data was gathered about their interaction with the system, including search logs, sound and video recording and mouse interactions. A detailed analysis of the user-centered evaluation data was done, and results from the evaluations guided further development of the prototypes.

A meta-analysis of all evaluation results at component level and user level was carried out, allowing an objective image of the progress of the Khresmoi project to be created. Khresmoi also organized the search task in the CLEF eHealth evaluation campaign in 2013. Nurses created questions that were likely to be asked by patients after looking at their hospital discharge letter, and participants in the evaluation campaign tried various approaches to finding relevant information to answer these questions from the collection of Khresmoi websites.

6 User Involvement, Promotion and Awareness

Khresmoi has been active at fairs, with highlights being:

- A booth at the ICT 2013 Event in Vilnius, Lithuania

- A booth at the CeBIT in Hannover, Germany

- A booth at the European Congress on Radiology (ECR) in Vienna, Austria

- Three educational exhibits at the yearly congress of the Radiological Society of North America (RSNA) in Chicago, Illinois, USA

Live demos of the Khresmoi prototypes in front of an audience were also shown at the following major events:

- 14th World Congress on Medical and Health Informatics (MedInfo) in Copenhagen, Denmark

- Health 2.0 Europe 2012 in Berlin, Germany
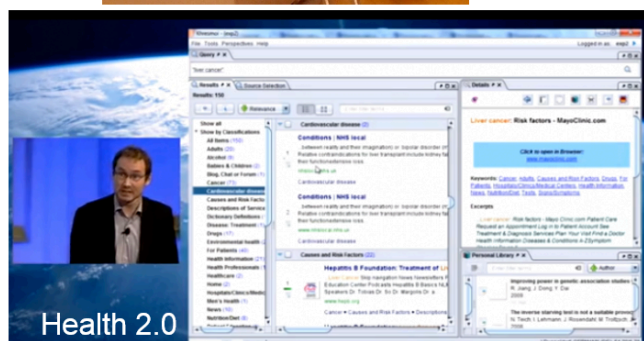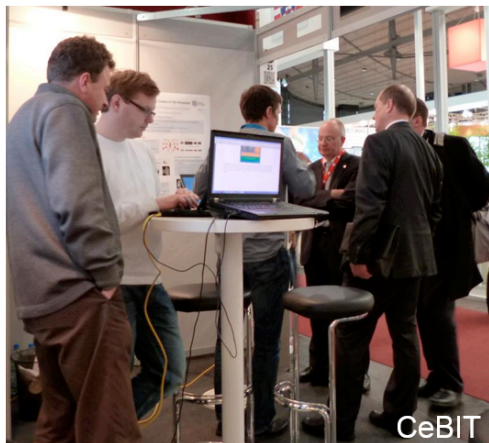
7 Future Work

The next major step in the Khresmoi project is updating the prototypes based on the results of the last round of evaluations, and evaluating the final prototypes. Evaluations will again be conducted with end users from the patient and medical practitioner communities, as well as with a group of radiologists. Finally, we plan to develop effective ways to exploit the extensive outputs of the Khresmoi project, which include annotated data, open source software and the prototypes described above.

A number of high impact dissemination activities are planned for year 4, including:

- Booth at the STAFAM Medical Conference for General Practitioners in Graz, Austria in November 2013
- Demonstration at the Radiological Society of North America (RSNA) Annual Meeting in Chicago, Illinois, USA in December 2013
- Booth at the European Conference on Radiology (ECR) in Vienna, Austria in March 2014
- Khresmoi Booth at the CeBIT 2014 in Hannover, Germany in March 2014

8 Further Information

Khresmoi webpage: http://khresmoi.eu

Fifth Khresmoi Newsletter: http://khresmoi.eu/assets/Newsletter/newsletter5-khresmoi.pdf

Khresmoi for Everyone prototype: http://everyone.khresmoi.eu

Khresmoi Professional prototype: http://professional.khresmoi.eu