

**Grant Agreement Number: 257528**

**KHRESMOI**

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## **D3.5: Report on user interface adaptations for handicapped people**

<b>Deliverable number</b>	<i>D3.5</i>
<b>Dissemination level</b>	<i>Public</i>
<b>Delivery data</b>	<i>28.02.2014</i>
<b>Status</b>	<i>Final</i>
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*This project is supported by the European Commission under the Information and Communication Technologies (ICT) Theme of the 7th Framework Programme for Research and Technological Development.*

## Executive Summary

This document contains information about accessibility providing adaptations to the user interfaces for the *Khresmoi for Everyone* and *Khresmoi Professional* prototypes. User interviews were conducted that favoured the approach to focus on visually impaired users. For both interfaces alternative font and colour settings were implemented improving accessibility for people with reduced eye sight. Furthermore, we explored ideas on how to allow blind and physically handicapped people to use the system. Although screen readers and eye tracking controls seem promising, an implementation of these features is out of the scope of the project.

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## Abbreviations

UDE	University of Duisburg-Essen
HON	Health On The Net
ezDL	Easy Access to Digital Libraries
K4E	Khresmoi for Everyone
KP	Khresmoi Professional

## 1 Introduction

Usage of computer systems usually requires good eyesight (for reading from a screen) as well as a high level of fine motor hand movements (for using keyboard and mouse for input). Small fonts in applications or websites may prove difficult to read even with minor visual impairment. On the other hand, some people may find it cumbersome to click on small buttons or input fields when facing typical age related decay of fine motor skills. With Khresmoi being an eHealth search system, it is reasonable to assume it will be more heavily used by elderly people than other computer systems or online platforms [3]. While only usage data from a live system can provide insight about that hypothesis, it is important to examine possible steps towards a user interface which introduces as few as possible hurdles for all potential users.

Task 3.5 in the Khresmoi DOW was created to address this issue. It introduced the idea of extending the interface to allow assistive technologies. The negative effects of reduced eye sight may be overcome with simple adaptive strategies such as increasing the font size or using different colour schemas. For severe cases the system could feature a magnifier function or even a screen reader. Providing mouse-less access to a system or voice control mechanisms may reduce fine motor requirements. The World Wide Web Consortium (W3C) Web Content Accessibility Guidelines (WCAG) 2.0 <sup>1</sup> give a good overview of possible adaptations to user interfaces. They also include the ideas mentioned above.

This document describes interface adaptations that have been explored in the course of this task for different Khresmoi user interfaces. It is structured as follows: In chapter 2 user interviews conducted with impaired persons are introduced. They form the foundation for the developments explained in chapter 3 and 4 focusing on the Khresmoi for Everyone (K4E) <sup>2</sup> and the Khresmoi Professional (KP) user interface developed by HON and UDE respectively. The main aspects of this document are summarised in chapter 5.

## 2 Conducted interviews with handicapped persons

To gather information about barriers introduced by the Khresmoi Professional (KP) user interface a series of user interviews was conducted at UDE in late 2012. Since the KP interface was still in an early state of development, the related ezDL <sup>3</sup> interface was used for these interviews. The ezDL and KP interfaces share the same code base and features with respect to accessibility. Naturally, the system did not at that time include any specialized health search features or health related sources. Since the focus of the user interviews was on accessibility and no real search tasks were conducted, this fact did not impose a problem. The focus of the interviews was to observe how impaired persons can get a stable version of the interface to work on their home or work machines.

Therefore, seven visually impaired persons were visited at home. Each interview lasted for up to an hour and included various topics, covering general aspects of computer usage with a disability to downloading and running the actual application without external help. The following paragraph briefly summarizes the major outcomes of the user interviews:

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<sup>1</sup>W3C, Web Content Accessibility Guidelines (WCAG) 2.0, <http://www.w3.org/TR/WCAG20/>

<sup>2</sup><http://everyone.khresmoi.eu/hon-search>

<sup>3</sup><http://www.ezdl.de>

- Using full featured Java programs might introduce the possibility of technical difficulties that are hard to recover from without help. For example a security warning given by one participants browser upon loading of ezDL was not read properly by her screen reader software causing her to call for assistance before even loading the program.
- Once the software was running properly we examined how commercial screen readers commonly used by the participant worked with the interface. We found that many interface elements could not be identified by screen readers.
- Common interface elements such as icon and graphics lacked meaningful textual representation to be used by screen readers.
- Participants had trouble controlling the interface without a mouse since not all functionality was accessible by keyboard short cuts.
- Several users remarked about the necessity of customizable font sizes which was not supported by the examined version of the interface.
- Similarly some participants wanted to alter the contrast and colour settings which was also not possible.

Based on the outcomes of the user interviews we explored two potential major fields of interface accessibility improvement, namely supporting screen readers as well as allowing font and colour changes by the users. Additionally, we investigated if a mouse and keyboard less control of the interface is generally possible by using eye movements as a system input. Each of these ideas is described in chapter 4.

## 3 Khresmoi for Everyone

Exploring the use cases for Khresmoi for Everyone (K4E), based on previous experience in web site development for disabled and conclusions drawn in the previous section, we at HON have explored various possibilities of helping the visually impaired users.

In order to enable people with disabilities, as well as any other person to participate equally, we have optimized the accessibility of the K4E interface. The World Wide Web Consortium (W3C) Web Content Accessibility Guidelines (WCAG) 2.0 <sup>4</sup> guidelines were integrated in order to maximize the accessibility of the interface. Several levels can be chosen, but it is recommendable to use at least level AA success criteria. In addition, it is recommended to implement the user agent guidelines (web browser, media player etc.). <sup>5</sup>

### 3.1 Screen reader

HON has tested the possibility of integrating the Readspeak<sup>6</sup> in order to vocalize the K4E search results. Performed test have shown that due to nature of the application, due to Ajax

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<sup>4</sup>W3C, Web Content Accessibility Guidelines (WCAG) 2.0, <http://www.w3.org/TR/WCAG20/>

<sup>5</sup>W3C, User Agent Accessibility Guidelines (UAAG) 2.0, <http://www.w3.org/TR/UAAG20/>

<sup>6</sup><http://www.readspeaker.com>

queries and Javascript it is very difficult if not impossible to feed the Readspeakr with the text to vocalize in real time. This led to the conclusion that a redesign of the interface would be required in order for this tool to be integrated. Additionally, user in need of content vocalization usually are already in possession of the screen reading software to which they are accustomed, which has been shown in the interviews described in the Section 2. For the reasons stated above, it was decided not to pursue the integration of this tool into K4E.

### 3.2 Font Size

On the right hand side of the interface user can find 3 buttons (Figure 1) marked by “+”, “-”, “⊙” that enable the font size to be increased, decreased or to clear previous font size manipulation.

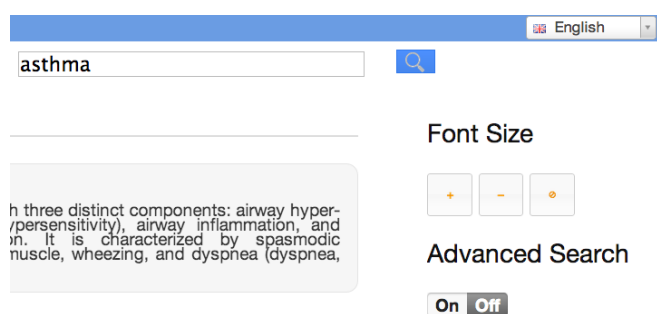


Figure 1: K4E Font size changer

Figure 2 gives examples of the results returned by the K4E in the original font size (Figure 2 a), increased font size in simple (Figure 2 b) and advanced [2] mode (Figure 2 c).

### 3.3 Contrast

To deal with too much screen reflection that may occur two software colouring schemas are being implemented into K4E. Black/yellow background/lettering combination is shown in Figure 3 for simple (a) and advanced (b) mode. The second colouring schema given in Figure 4 for simple (a) / advanced (b) mode, is blue/yellow/white. In the second colouring schema two distinct lettering colours were used, namely white for links and yellow for the search result's snippet text. However, this feature is still in its testing phase and is not available for the public version of the K4E interface.

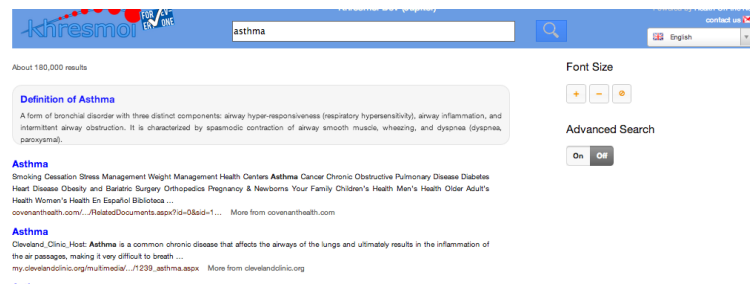
## 4 Khresmoi Professional

### 4.1 Providing alternative colour and contrast settings

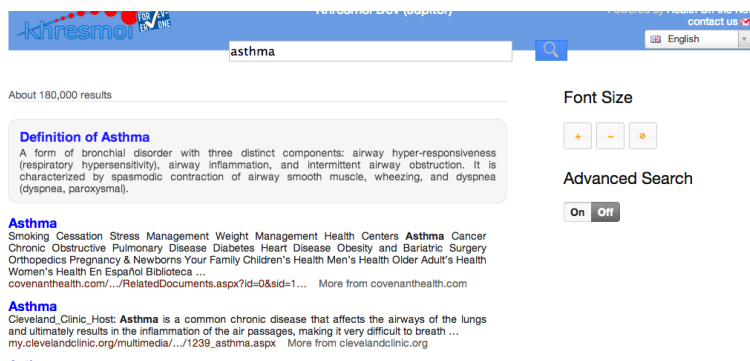
The Khresmoi Professional prototype is described in Deliverable 3.6[1]. Although the system is mainly targeted at professional users, we decided to support adaptations described in chapter 2—like different colour schemas and font sizes—as well. Following the same arguments we extended the framework with means to change the look and feel during the application's runtime.



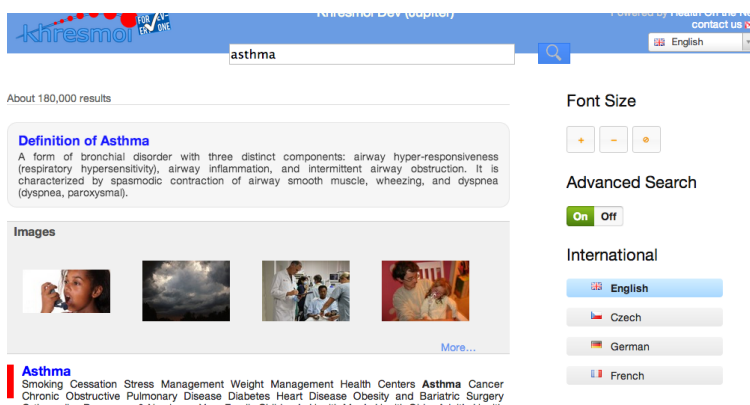
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a) K4E Original font size



b) K4E Increased font size (simple mode)



c) K4E Increased font size (advanced mode)

Figure 2: K4E Font size implementation

Fonts and the font size of the interface are also part of this look and feel package. We included the possibility to configure preferred font sizes in the user options for registered users. Therefore, we pre-defined a fixed set of available sizes. This significantly reduces implementation complexity and ensures all interface elements are displayed correctly at any time.

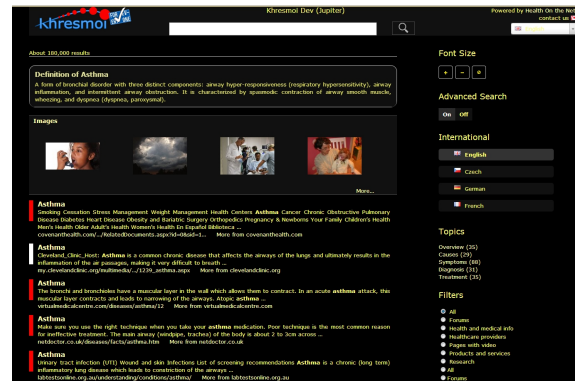
Figure 5 shows the Khresmoi Professional user interface with alternative font sizing activated. In this example the user chose the medium font enlargement available in the options menu. For comparison the default font size is shown in Figure 6.

The alternative colour setting for the KP interface is shown in Figure 7. We chose a set up which is visually similar to the one from the K4E interface.

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(a) B/Y simple



(b) B/Y advanced

Figure 3: K4E Black-Yellow contrast



(a) B/Y/W simple



(b) B/Y/W advanced

Figure 4: K4E Blue-Yellow/White contrast

## 4.2 Connecting Khresmoi Professional to a screen reader

UDE conducted experiments with various screen readers as well. Most notably JAWS<sup>7</sup> has been used for testing purposes. Regardless of the product used, screen readers interact with Java Swing applications by utilizing the Java accessible API. The main idea is that all interface components define an alternative descriptive text. In simple cases this may be the same as the text already provided in the user interface, like for buttons or label for interface components. But also graphics and symbols can be enriched by further information. Users with strong vision impairment can be guided by the application through their work flow by defining *tabbing paths*. Tabbing refers to the user employing the tab key to navigate to different interface elements. Pressing the tab key will make a new interface element get the focus which in turn triggers the screen reader to read out the descriptive text of that element. Elements that allow input, like the query box, will also announce that fact. Control elements, like check boxes or drop down menus, include a similar notification, activation status information as well as the descriptions of

<sup>7</sup><http://www.freedomscientific.com/products/fs/jaws-product-page.asp>

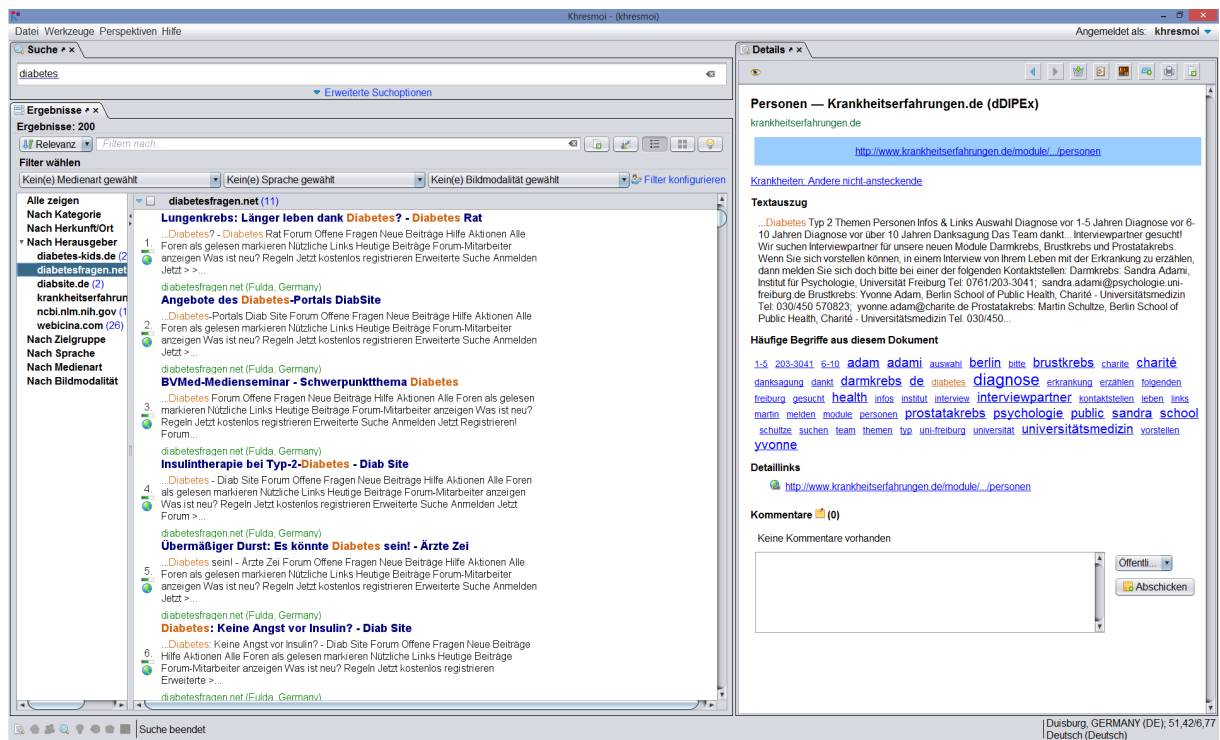


Figure 5: The Khresmoi Professional interface with larger font

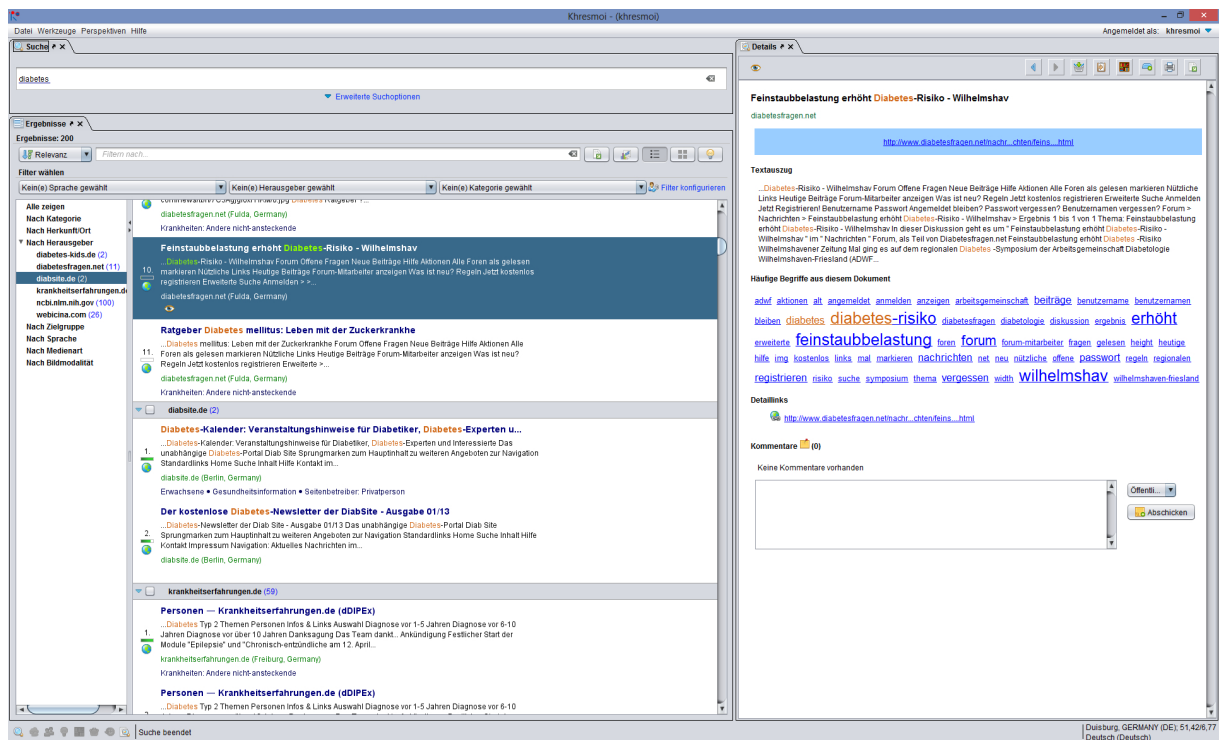


Figure 6: The Khresmoi Professional interface with normal font

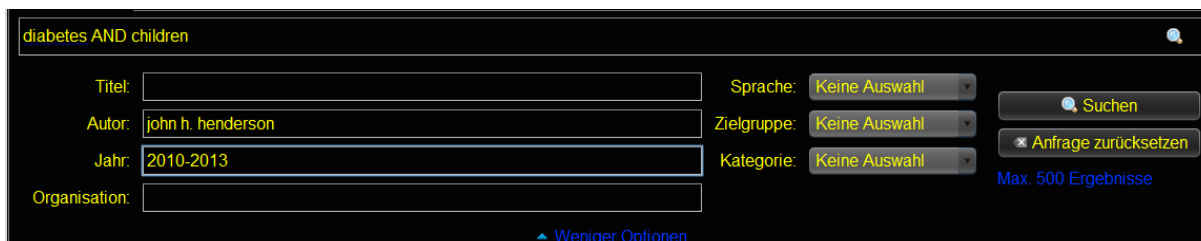


Figure 7: Query box of Khresmoi Professional interface in high contrast schema

all other available selections. Furthermore, the application allows the user to access all major tools and functions by keyboard short cuts. These are also listed in a special menu entry, which is equipped with additional descriptive texts for the screen reader to use.

Providing these kinds of accessibility features requires the developer to define labels and tabbing paths for every single interface element. Therefore, it has to be implemented at the very end of a development phase after the interface layout has been finalized. By the time of writing of this document the development was still ongoing. By the time of the final prototype release the matter will have been resolved.

### 4.3 Controlling Khresmoi professional by means of eye movement

Computer usage requires fine motor movements that physically impaired users may not be able to conduct. Voice input is one possible solution to overcome this problem. It is currently in focus of research in the context of mobile applications.

For the Khresmoi project we explored a different solution, relying on the eyes as an input mean. Therefore, the following steps were executed by UDE, each of which is described in the following section in more detail.

- Set up a use case for eye movement input.
- Explore technical requirements for this use case.
- Develop an implementation plan.
- Evaluate the plan with the help of impaired persons.

Moving away from the standard input devices – mouse and keyboard – is a drastic change in computer usage style. Nevertheless, it may be a viable option for impaired users that otherwise could not use the system at all. To gain insight about the use case we designed a questionnaire and visited six impaired persons. While all of the responses were generally very positive about the idea of controlling a computer system by eye movements only three of the persons were interested in using an online search application. Most users would prefer to browse the web and use the eye tracker to gain access to e-mail and social networks. While this trend is not surprising given the difficulties impaired persons must face every day, it raises concerns about the cost to benefit ratio of an eye movement control implementation.

To further investigate this matter we estimated the development effort required to implement the solution. Eye tracking consists of hardware and software components that are very specialized. First we also explored technical limitations introduced by the eye tracking hardware. Our set up includes a table mounted device with a 120hz sampling rate and a resolution of 1650\*1050 pixel and an angle accuracy of  $0.4^\circ$ . This leads to the question whether it is possible to keep the interface mainly unchanged or redesign is required due to technical limitations. First we investigated the size of the minimal screen area that can be reliably used as an input component. As a search system requires text input we developed a virtual keyboard (see Figure 8) to pursue that goal. By running eye tracking experiments with the virtual keyboard we can both evaluate reasonable font and bounding box sizes as well as the overall usability of the keyboard itself. During the course of the experiments we also gathered feedback from the participants by interviewing them. The results from the actual tests are described below, followed by a short summary of the main idea generated by user interviews.



Figure 8: Virtual keyboard used for the lab tests

We found a minimum bounding box size of 40 by 40 pixel to be the lower bound for accurate consciously controlled fixations. Smaller targets caused the test subject to get tiered quickly. While it is possible that a prolonged system usage may generate a learning effect, we recommend not to include targets smaller than that size. We also determined a minimum gap of 10 pixels between trigger components on screen. This is to clearly separate fixations between objects, regardless of *fixation drift* which happen due to errors in human ocular movements.

Our pilot study also yielded ideas about essential features of an eye tracking control set up. Participants reported about the need to set a custom fixation trigger duration, i.e. the time the system lets pass before a prolonged fixation is interpreted as a click. In our experiment we found a duration of 1 up to 3 seconds to be reasonable. Even with a customizable threshold this fixation trigger is error prone. Therefore, the idea of a two staged process was introduced. Instead of executing the action right after the time expires, a visual indication is introduced after a fixation is longer than a typical reading fixation. A possible solutions could be a hour glass being displayed in the peripheral field of vision. It could also be animated by filling it up as the trigger expires. Some interaction interface elements like buttons or menu items could also



be displayed as pressed down after the first trigger is met. This gives the user feedback that the system is about to execute an action and may help to prevent unwanted inputs.

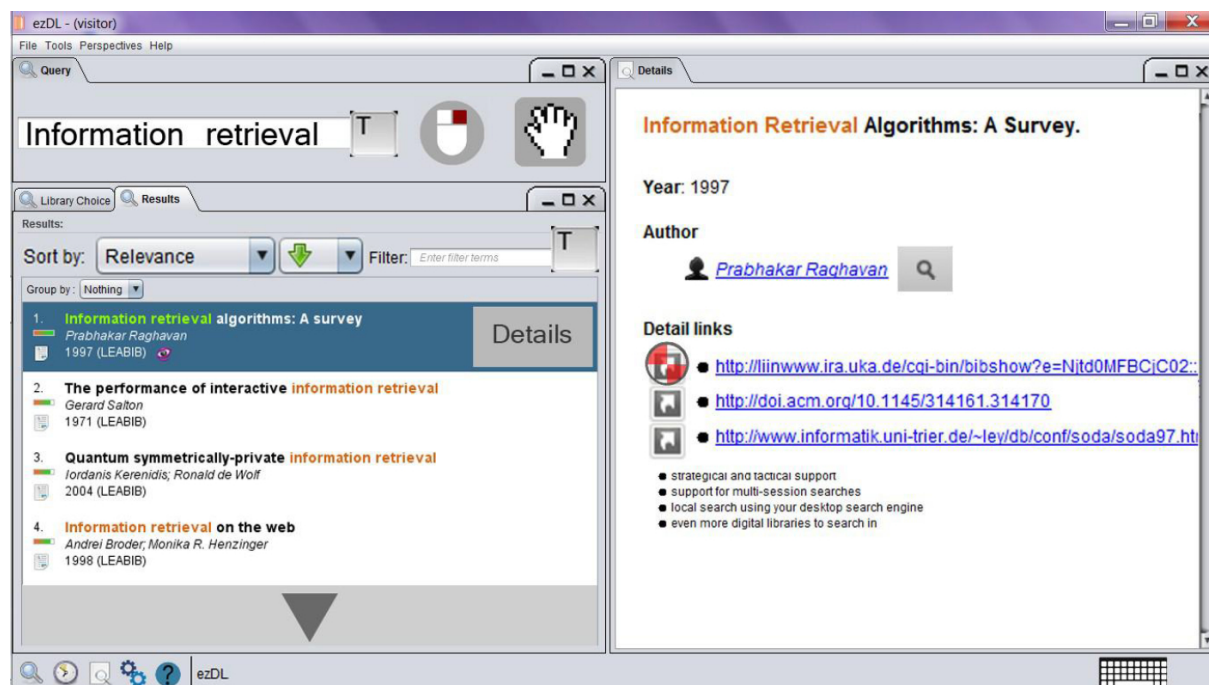


Figure 9: Custom version of ezDL for eye control usage

The aforementioned limitations of the eye tracking hardware and the human ocular system make several adaptations to an application interface necessary. For example, buttons and other control elements need to be enlarged and the right click functionality has been mapped to a special interaction element. An example of the ezDL interface with possible eye movements controls included is shown in Figure 9.

Regarding the estimation of development effort we also had a look at the software components of the eye tracking set up. Unfortunately, these proved to be a limiting factor. To the best of our knowledge no open source framework for gathering gaze data exists. Therefore, we need to rely on commercial software available to the consortium. Unfortunately, it does not feature an open interface to communicate with external software, like the Khresmoi professional prototype. As a result, a full featured implementation of an eye movement control is out of the scope of this project and was not further pursued.

## 5 Conclusion

In this document a series of user interviews was described. As a result of these interviews two main ideas were developed and implemented for both the Khresmoi for Everyone and the Khresmoi Professional interface. The final versions of the prototypes include an interface version for visually impaired users that offers larger fonts. Additionally, users can choose a

version with a different colour schema which reduces possible reflections on the screen and is easier to read under some conditions.

Furthermore, the integration of a screen reader was discussed. We opted against an integration mainly because affected persons will mostly already have their own preferred screen readers installed on their system. These screen readers work on operation system level. We described how both Khresmoi Professional and Khresmoi for Everyone interfaces have been made compatible with this kind of screen readers.

For the physically impaired users that are unable to operate mouse and keyboard the concept of using eye movements as an input device was introduced. We conducted a small study in a lab setting and explored software and hardware requirements for realizing this idea. While participants were in general positive about the idea, high development effort, hardware limitations and the small potential target group caused us to not further follow this approach.

## References

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