A new Virtual Microscope at the Medical University of Graz

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I. INTRODUCTION AND BACKGROUND

In 2002 the Medical University of Graz (MUG) introduced its first Learning Management System (LMS), the so called the Virtual Medical Campus Graz (VMC). Since then eLearning was fostered by the MUG and the VMC serves now as the portal to the eLearning content of the MUG [1], [2], [3], [4]. In 2002 also the virtual microscope 1.0 (VM 1.0) was developed and introduced for the students.

The basic idea was to offer the functionality of a microscope via an interactive application which is integrated within the LMS of the university. The main advantages of that concept were saving costs, enhancing the flexibility for students and utilizing additional features and possibilities offered by new media.

Due to the fact that having a virtual microscope thousands of students work with at the same time, we reduced the costs for our university, as there was no more the need to buy hundreds of expensive physical microscopes to be used in exercise lessons. Only one scanner device is needed to digitize the images of a microscope which can then be used by the virtual application. Since the virtual microscope is offered via the eLearning system flexibility for students in terms of time and location is provided as well. Students can use the virtual microscope whenever and wherever they want to. Last but not least we had the additional possibility of setting markers in combination with explanatory text within the images to directly point out interesting regions for students within a digital sample.

In the meantime the concept of the virtual microscope has also been introduced broadly into the medical-IT sector. Huge commercial companies such as Aurora MSC [5] implemented complex and highly specialized virtual microscope applications to be used by medical experts like pathologists and dermatologists.

After more than eight years the technology as well as the functionality provided by our virtual microscope was now out-dated. With 1st of October 2010 we introduced VMC/Moodle [6] as a new primary LMS at the MUG. In November 2010 we further decided to replace our existing VM 1.0 by a new software with state of the art technology and functionality.

II. REQUIREMENTS OF NEW VM

Together with our teachers we defined requirements for VM 2.0. The VM 2.0 has to provide the existing functionality of VM 1.0 and shall provide the following additional features:

Functionality

- Mini map and magnified view with at least 6 zoom levels, preferably progressive zoom shall be provided such as within Google maps [7]

- The zoom rectangle within the mini map can be moved simply by dragging the rectangle with the mouse, additionally navigation buttons such as in VM 1.0 shall be provided

- Possibility of setting of different markers (arrow, circle, rectangle, polygon) together with explanatory text

- Possibility of setting markers together with explanatory audio instead of text

Technology

- must be useable with standard web browsers, no installation of additional software, no stand alone clients → therefore the client should be implemented with latest Adobe Flash technology, which is already part of each common browser system (e.g. IE9, Firefox 6, Opera 11)

- if additional database software is necessary an open source database such as PostgreSQL or MySQL shall be applicable

User interface and navigation

From a user interface and navigational point of view, it was very important to keep the basic elements of VM 1.0, on the other hand it should provide a state of the art usability which is commonly known from today's web applications. There are four main areas of the VM which shall be clearly recognizable by the user and easily to use:

- navigation area with mini map

- information

- markers

- visualization window with object to investigate

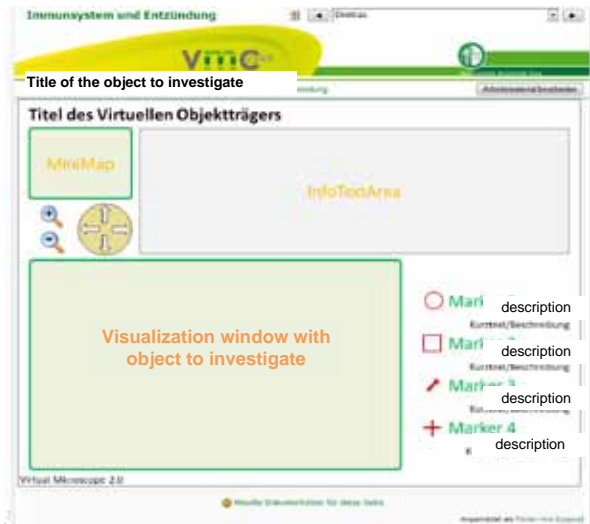In Figure 1 a mock-up of the desired user interface for the new VM is given.

Figure 1. User interface mock-up for the new VM

III. MARKET OVERVIEW, COMPARISON AND PRODUCT DECISION

Having the requirements defined we performed a market research. Basically there exist two groups of applications providing the functionality of a virtual microscope:

1. Desktop applications (client software has to be installed)

2. Web based applications

The larger group are the desktop applications, where also huge and highly specialized commercial solutions can be found. Since we had the requirement that the virtual microscope must be useable for students from any web browser, we continued investigation only within the second group. Here we found three applications which met our requirements: Zoomify [8], WebMic [9] and the VM of FH-Joanneum.

Based on the market overview we evaluated the three applications according to the requirements defined by us. The results of this evaluation are given in TABLE I. .

TABLE I. COMPARISON AND EVALUATION OF AVAILABLE WEB BASED VIRTUAL MICROSCOPE APPLICATIONS	Products		
	Zoomify	*VM of FH-Joanneum*	*WebMic*
At least 6 levels of detail (zoom)	Yes	No (only 4 levels of detail)	No (only 3 levels of detail)
Minimap and magnified view	Yes	Yes	Yes
Online mipmapping (no fixed	Yes	No	No

number of level of details, progressive zoom)			
Dragging of the magnified area within the mini map by the mouse	Yes	Yes	Yes
Setting of markers	Yes	No	Yes, but in commercial product markers cannot be set by user
Different types of markers	Yes	No	Yes
Additional text to markers	Yes	No	Yes
Additional audio to markers	No	No	No
Technology	Flash	Flash	Java (VM must be installed)
Customers from medical area	Yes	Yes	Yes
Source Code provided	Yes	Maybe, when co-operation is defined	No
License fees	$ 695 (for educational institutions 30% discount)	Currently comercially not available	34, 95 € Note: CD-ROM, no client server version
Overall rating (1 – 3 Smilies)	**J J J**	**J**	**J**

Based on this evaluation Zoomify meets best the requirements defined by the MUG on the virtual microscope 2.0. Due to its Flash technology this application can be easily integrated into our LMS VMC/Moodle. Even though a commercial product has the obvious disadvantage of generating a kind of dependency on the company, this is fairly compensated by the facts that the original source code is provided, the company has a huge number of customers (also in medical area) and a very attractive price is provided.

IV.   TECHNICAL REALIZATION AND MIGRATION

Initial trials with the VM were very successful and the first migrated VMs were soon available within our LMS VMC/Moodle and used by the students. From begin of May 2011 we started with the general migration process. All in all more than 350 old VMs will now be migrated to the new technology. Students are not hindered during this migration phase hence the migration can be done piece by piece. Each time a migration is finalized, the old VM is deleted and only the new VM is available.
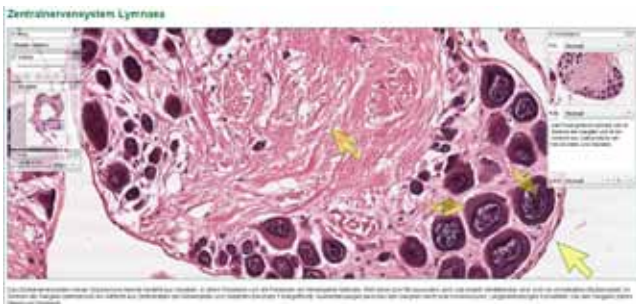

Figure 2. Example of a migrated VM within the MUG LMS VMC/Moodle

In Figure 2 a VM with the new technology within our LMS VMC/Moodle is visualized. Within the upper left area the navigation functionalities are provided, including the mini map and an easy navigation within the mini map by moving the blue rectangle. In the upper right corner so called "points of interest" (POI) are provided in a drop down box next to explanatory text to this marker just below in the text box. These are areas of interest within the investigation object indicated by the teacher to be closely watched by the student. To each POI a marker is associated - in this example arrows - indicating exactly the position of the areas within the high resolution image to be closer investigated by the student. By clicking on the POI the main viewing window automatically positions itself to the corresponding marker. A magnification of the main area can be either achieved by using the mouse wheel, or by using the zoom tool with the navigation functions provided in the upper left corner.

The VM viewer itself is a Flash application and for each migrated object the application is integrated as a "link" within VMC/Moodle.

V. Conclusions

As preliminary conclusions we can state, that it is most probably more expensive to develop an own virtual microscope application than buying and adapting one of the already existing applications. There are many commercial but also open source virtual microscope applications with a vast number of features - hence it is very likely that an appropriate application will be found.

The integration of the new VM into our LMS VMC/Moodle works perfectly. Also the stability of the application is very satisfying, we are not aware of any client application problems or crashes.

From the evaluation a very clear commitment of the students for the extensive usability improvement of the new VM was given. The VM is very useful for the self evaluation of students. Finally from the open question testimonials like "ideally to learn", "successful update – congratulations", "good usability", "great service", "you did a great job! Now I will much more likely work with the VM than before" were very encouraging for us.

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