Personalized e-learning software systems. Extending the solution to assist visually impaired users

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Discussing the subject of e-learning in the context of the latest updates of technology nowadays represents quite a challenge when the topic must be addressed to special classes of computer users. The paper will present a theoretical framework for visually impaired persons, followed by a technical implementation of the concept in relation with the e-learning context. The solution proposes an analytical approach over the computer aided learning mechanism, defining the concept of personalized learning and providing an example of implementation for a software system that, subsequently, offers support and assistance for visually impaired computer users. The technique implements a specially designed software library, integrates it in an e-learning software system and combines the power of a web-based solution with the support and guidance offered by a text-to-speech integration, resulting into a reliable e-learning software implementation. The paper also focuses on the theoretical aspects of the problem, and will present its conclusions at the end.

Keywords: *e-learning, personalized learning, text-to-speech, JAWS, integration*

1 Introduction

The interfaces and locations where computerization entered the learning process have changed dramatically since the advent of the web. In the last decade, classic research has been replaced by web based research, especially because libraries have changed from the printed format and their physical spaces for storage, into electronic learning resources and virtual laboratories. At the same time, the increase of computerization field has major implications on how students perceived their need to access the information (location, rating content, use or creation of information). In this context, the online field, search engines updates and the exponential growth of the web 2.0 and its technologies proposed, allowed this irreversible change of the current context information. [9]

Undoubtedly, the most dramatic rise in training and development over the past 20 years has been the increased use of technology, explained by the convergence of technologies used to deliver content. [1]

Adopting advanced forms of disseminating information and new information technology solutions proposed, was a main stay in the extensive development of e-learning. Due to the popularization and wide applicability of internet technologies, it was possible to develop virtual learning environments which broke temporal or spatial barriers of the research. From the point of view of information technology development process, each forward step made by internet is an impact prerequisite and a positive effect for distance education model [11], bringing with each evolving value to the field.

Since e-learning systems are becoming more available, many instructors have begun to use these systems in their teaching process. Their desire to try to use such systems, however, doesn't guarantee that they will continue to use them on long term. Previous studies are showing that continued use of the information system is determined by its perceived usefulness. The studies made by Roca [10] and Chiu [3] indicate a major factor in the continued use of the system, which represents perceived usefulness, made from the actual experience of use. Therefore,

the design of an information system should consider all the useful features for its users. However, these features cannot be established or updated before they use the system and provide comments upon it. [13]

Another considered aspect is the personalized learning. This occurs when e-learning systems make deliberate efforts to adapt to the educational experiences that fit the needs, goals, skills and interests of its students. Researchers have recently begun to investigate various techniques to help teachers improve e-learning systems. [7]

Introducing these as a starting point, I have developed an e-learning model that offers a secure working-base for e-learning, considering the technology and functionality included.

What this article aims, is to present practical solution in order to assist visually impaired users, taking into consideration financial resources and current technology standards.

2. Solutions for visually impaired persons

As the use of virtual learning environments and other computer-based educational resources is increasing every day, the concern about the inclusion of any course in these systems is crucial. If educational instruments are not developed properly, the use of such systems can become an additional factor in the exclusion of students with disabilities from educational process. However, it is important to consider how the use of the computer has increased to all more opportunities in order to make their lives easier. The development of assistive technologies has provided great opportunities for people with disabilities to transform their way of life in a productive, efficient and result oriented way.

Although in recent years many advances have been made regarding assistive technologies, it was also found a number of shortcomings, somehow inherent in the interaction with common technologies. For example, graphical resources of the images can be automatically translated into text, in order to be read by the screen reader. The presence of elements of interaction that can be achieved only through pointing devices is also a barrier for people with visual impairment.

Promoting inclusion in regular educational fields showed a genuine concern for both teachers and government officials. Therefore, promoting social inclusion, regardless of disability, is an important issue to be addressed in the context of e-learning environments. Making e-learning systems accessible to all was a challenge. Indeed, many e-learning systems fail to adhere to web accessibility guidelines. [4] The challenge of designing these systems more affordable is more serious if we take into consideration the synchronized interactive technologies and multimedia resources.

Many reports of the researchers are showing the efforts to promote inclusion in e-learning field. One example is the University Notebook Model. [8] One of the aims of the project is to develop specific applications, which will support the production of wide e-learning systems. The Center of Studies for the Blind and Partially Blind Students, involved in this project, has devoted special attention to questions about the blind or visually impaired persons. The Center investigates, for example, issues to be considered when preparing a course, issues of the documents used in higher education, the use of multimedia, the availability of documents and others.

Other resources that can improve e-learning applications from the point of view of blind people are adopting and integrating a suitable screen reader and voice recognition systems. Wald [14] analyzed the way automatic speech recognition can support universal access to communication and learning, by making text synchronized with speaking. This implies support for the blind persons, for those with visual impairments

or dyslexia in order to read and search for information.

Traditional desktop screen readers, such as JAWS1 and Virtual Vision2, are already part of life for the blind people. Many efforts have been made and are made to implement them. For example, Chen [2] presented the Audio Browser software, which is designed with a standard Personal Digital Assistant (PDA), having a number of features that are making the interface more accessible and easier to use. It is used a touch screen, buttons to enter data and non-speech audio. The response for the user is communicated through "speech", thus allowing easy navigation through stored information and also for accessing the system controls.

IWB (Interactive Whiteboards) became a common resource in the study classes around the world. Slay [12] shows the reports of the benefits of this technology of some teachers, such as effectiveness, flexibility, versatility, opportunity to access multimedia content, support multiple needs in a single lesson, and the ability to handle the teaching that class requires it, allowing teachers to maintain control over the training group, which would be more difficult to achieve with a computer. [4]

In the process of testing visually impaired persons, the study made by Hochheiser [5] presents in detail a probabilistic strategy approach of how these people use web interfaces. The sample studied by the author shows that, by defining a tree structure of web pages, visually impaired persons will have almost a normal experience in using software testing platform.

In Romania, computer-assisted learning for people with disabilities is at an early stage of development. There are initiatives in this regard, especially since both the Romanian legislation and the European Union encourages the development and promotes assisted software, using e-learning. [6]

3. E-learning application

For the ease of development, in order to take as many out-of-the-box features that are compatible with a wide range of devices and browsers, as well as better accessibility, the Twitter Bootstrap framework has been used in developing the graphic interface.

The reason for this choice is given by the fact that the Twitter Bootstrap provides a wide variety of components and tools for the development of a consistent interface, which operates on both mobile devices and desktop units, with higher resolution. Therefore, the arrangement of elements on the page can dynamically change, depending on the resolution using the method behind the media queries and the responsive design.

The user`s interface can be separated into modules accessible to unauthenticated users, that are considered by the system as "guests", modules available to authenticated users as students and modules for teachers or administrators. The Global Diagram is shown in Figure 1.

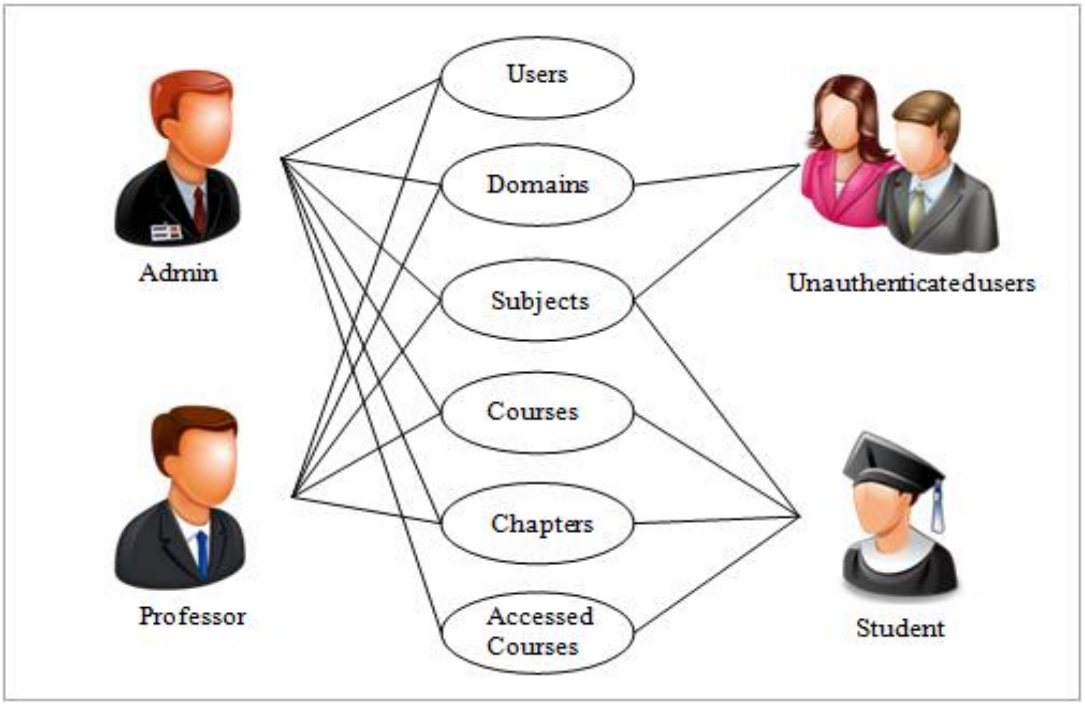

Fig. 1. Global Diagram

The Admin user (administrator) in the context of the application is a teacher with a set of extended rights, so that an Admin can only be changed by a user with equal rights and has access (such as teachers) to all the functionality of the application.

At the moment of the first access by a new user, he will have access to the initial screen that contains a low number of information about the system and the possibility of creating an access account, these being the pages for unauthenticated users.

The Main Page is shown in Figure 2. It exposes information about the number of courses available under each subject belonging to all domains registered, but without the possibility of being accessed. The chose of this interface has the main argument the wish to attract as users only those students who are strictly interested in the available material.

In the module accessible to the students, the user which successfully authenticates is greeted by a page as shown in Figure 3, with access to its own domain of study (chosen at registration) and to the latest accessed courses. The student can view all the information exposed by the teacher (in the domain) and can edit his own profile - changing the password is the only element that can be edited for the moment as a measure taken for avoiding identity theft situations.

Another functionality implemented is draining the list of accessed courses. This option was introduced in order to allow the user to decide on the amount of information displayed, depending on the importance given.

The page with the greatest importance, to which have access both advanced users who have rights, but especially students (to whom it is particularly intended) is the Course detailed Page (Figure 4).

Fig. 2. Main Page - unauthenticated users

Fig. 3. Main Page – Student module

3. The proposed solution

Given the above, it was started an investigation process of the situation, by contacting the staff of Centre of functional rehabilitation for visually impaired in Braşov. This center aims to specific social and professional inclusion of visually impaired adults at risk of social marginalization and increase their quality of life through the provision of comprehensive social services. In matters of informatics aspects, beneficiaries of the center are guided by a specialist to use the Braille display, keyboard and the working stations on which is installed a speech synthesis application.

In terms of technology, the issue raised by the person responsible for training those who want to learn how to use the computer, was related to the application of speech synthesis. The one used in the rehabilitation center is JAWS1. From personal observations and explanations received, it could easily be concluded that the voice provided by the application and the fact that it does not include Romanian language, make it extremely difficult to understand the information which is "read". Newer versions of JAWS program contain substantial improvements, but the need to purchase a separate license for each working station is a considerable financial effort, especially in the socio-economic conditions of our country. Therefore, at least for the moment, upgrading and updating to the new version of JAWS software is not possible.

In order to assist people with visual disabilities, we included in the course presentation page (Figure 4) the functionality accessed through the "Read the course" button.

Fig. 4. Course detailed Page

It invokes a JavaScript library called *meSpeak.js*. The application is a conversion of the popular open source Text-to-Speech algorithm, called eSpeak. The conversion is performed automatically by the *emscripten* tool that converts the C++ source code into JavaScript code compatible with modern versions of web browsers. The code that invokes this functionality is based on completion of a string given as argument (Figure 5).

Because meSpeak does not correctly interpret the accented characters (it omits them completely), it has been implemented a transliteration of special characters before being sent to the script in order to be read. Also other special characters (for example: . ! ? , ; :) cause interruption of reading, which is why I chose their elimination from the text before reading, using the function *gim* (*Global* - replacement occurs throughout the whole

text, not only at their first appearance, *case Insensitive*, *Multiline*).
In the implementation process, a particular attention was paid to the voice amplitude parameters adjustment (amplitude), the pause between words measured in units of millisecond (10^{-3} sec word gap), the pitch of the voice, the speed of speech (the number of words read per minute). Those have been adjusted by trial and error, in order to obtain a variant of speech as near as possible of the normal rhythm.

The use of this voice synthesis system has proven to be a sufficient and satisfactory choice to implement targeted functionality, allowing easy synthesis of Romanian language phrases with high level of voice quality, easily understood by the human operator.
The priority of development a new system of speech was considered to be significantly lower compared with the importance of such a system within the platform developed to support people with visual impairments

```
function readText(e) {
      var text = $('#courseContent').text();
      var rom = [
            ['a', (/[ăâ]/gim)],
            ['s', (/ș/gim)],
            ['t', (/ț/gim)],
            ['i', (/î/gim)],
            [' ', (/[^A-Za-z0-9\.!\?,;\:]/gim)]
      ];
      var i = 0;

      for(i = 0; i < rom.length; i++) {
            text = text.replace(rom[i][1], rom[i][0]);
      }
      console.warn($.trim(text));

      meSpeak.speak(text);
      meSpeak.speak(text, {amplitude:100, wordgap:5, pitch:20, speed:150});
      meSpeak.loadConfig("../../js/meSpeak/mespeak_config.json");
      meSpeak.loadVoice("../../js/meSpeak/voices/ro.json");
}
```

Fig. 5. *emscripten* functionality

4. Conclusions

Computer-assisted learning processes are a step forward to the global education model. Their effectiveness is determined by several factors, including that the final user can specify affinity towards this type of system, how the model implementation was made in educational institutions (directly dependent on the degree of national computerization of a country), funding volumes obtained for such implementations etc.
Therefore, the article presents at a detailed level, the current state of knowledge. The learning model proposed by the technology and functionality included, offers a secure working-base for e-learning. The solution is stable and easy to maintain in terms of resources and presents extensive capabilities, in comparison with other already existing in the consumer market.
An important element of personal contribution is the model which meets people with visual disabilities, solution that proves to be extremely useful to them. Such an application has proven to be necessary to facilitate the learning to these people and to make this process more enjoyable and more efficient. It is noted, thus, the developing of an integrated

software system specifically dedicated to learning and continuous training of any type of user, the only condition being, as in any field, that the person is willing to be trained.

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