Guidelines for Developing e-Learning System for Visually Impaired

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1 Introduction

The use of the Internet and new technologies in order to enhance the quality of life of the blind and the visually impaired has resulted in greater accessibility within this particular environment. This greater accessibility has been analyzed in terms of web-site development, i.e. applying existing standards and establishing new ones with the aim of developing an e-learning system for the blind and the visually impaired.

An accessible and usable web is part of the concept of e-accessibility, one of the key elements of e-inclusion, which aims to ensure that everyone without exception is included in the information society. Given this context, e-accessibility refers to the removal of technical barriers and difficulties which the blind or the visually impaired might encounter as they attempt to become part of the information society.

2 Aims

The primary aim of the study is to define guidelines for the development of an e-learning system with the aid of existing Web 2.0 technologies. Standards which should be observed while designing the system shall be defined from the aspect of usability. The problems which have been identified are based on the research carried out in the course of working with various associations for the blind and the visually impaired in the Zagreb area. Standards which have been defined in the guidelines provided by www.3.org (Web Content Accessibility Guidelines – WCAG 2.0) are not adapted to all web content. These are only some examples: registration forms, system login forms, column design, keyboard shortcuts, direction of navigation, information architecture and content search.

The guidelines that shall be defined will meet the criteria of universal design, which is focused exclusively on:

- Flexibility in use;
- Ease of use;
- Visible information.

Furthermore, the goals of the modeling framework of assistive technologies shall also be met. Some of these are [1]:

- application in any assistive technology system;
- the possibility of classifying assistive technology systems;
- defining the basic structure of assistive technology systems (in device specifications);

- developing new assistive technology systems with the aim of meeting the needs of end users;
- supporting the process of providing assistive technology to the user, aimed at the user accepting the solution provided;

It is possible to evaluate how successfully the guidelines have been applied by methods used to measure the Quality of Life of the end users [1] [2].

3 Methodology

The guidelines shall be defined using an analysis of the Learning Management Sys-tem (LMS) currently in use in Croatia (the Moodle-based Merlin), as well as the e-Student system in use at the Faculty of Transport and Traffic Sciences. The evaluation shall be carried out using the validation tool on (http://validator.w3.org) and the AChecker tool for evaluating e-accessibility [8].

4 Current situation

According to the latest Report on People with Disabilities, there are 529,103 individuals with varying disabilities currently residing in Croatia. This figure accounts for more than 10% of the total population [6]. There is a total of 18,317 blind or visually impaired people, which is an increase of 2,044 people on the year before. According to one estimate, the Internet is used by 10% of the blind population, and this figure is rising. The estimate is based on the documents and reports produced as part of the project "Komunikacijskim štapom do neovisnosti" ("The Communication Cane Leads to Independence") [5]. Several systems serving distance learning needs are in use in Croatia; three of which will be analyzed in this paper: Merlin, e-Student and AAI@EduHr.

Merlin is the LMS which is used as the e-learning and e-teaching platform at the University of Zagreb. It is based on Moodle, the open source tool which has been further modified and adapted to the needs of its users [9].

e-Student is the LMS used by the Faculty of Transport and Traffic Sciences and allows students authorized access to a variety of teaching materials, tasks, exercises and instructions. The system was developed in its entirety at the Faculty of Transport and Traffic Sciences [3] [11].

AAI@EduHr is the authentication and authorization infrastructure of the science and higher education system in Croatia. It is also a prerequisite for using all other systems which may be part of other university institutions in Croatia [10].

These LMS were analyzed using the AChecker tool and the following errors were identified:

- Merlin
  - Known problems – 48 errors
  - Potential problems – 300 errors.
- AAI@EduHr user login system
  - Known problems – no errors
  - Potential problems – 30 errors.

- E-student
  - Known problems – 11 errors
  - Potential problems – 63 errors.

The errors are due entirely to writing HTML code correctly, which refers to ALT attributes.

5 Defining guidelines for development of e-learning systems

Ensuring that the blind and the visually impaired have access to the content of a website and can use it is defined by W3C standards. Understanding information, as well as navigation and interaction between the website and the user define the website as accessible to all current users. An accessible website also attempts to ensure that all its users (regardless of disability or experience) have equal accessibility.

5.1 Standards of LMS development

Current standards of e-learning system development stem from the fundamental principles of website design available on www.w3.org [7]. The system developed at the Faculty of Transport and Traffic Sciences (e-student) is based on these standards, but none of the e-accessibility recommendations were followed. This was also the case with Merlin.

Elements used in the development of the e-student system:

- HTML (Hyper Text Markup Language) elements
- XML (Extensible Markup Language)
- Standards in writing headings and text (<h1..h6>, <p>)
- Standards in defining the visual aspect (CSS – Cascading Style Sheets)
- Dynamic features of the website using ASP (Active Server Pages).
- Elements used in the development of Moodle:
- HTML (Hyper Text Markup Language) elements
- XML (Extensible Markup Language)
- Standards in writing headings and text (<h1..h6>, <p>)
- Standards in defining the visual aspect (CSS – Cascading Style Sheets)
- Dynamic features of the website using PHP (Hypertext Preprocessor).

The basic criteria which the systems use in operation have not been adapted either. These include the user registration and login system, information search and adaptation to other devices (mobile terminal devices or tablets).

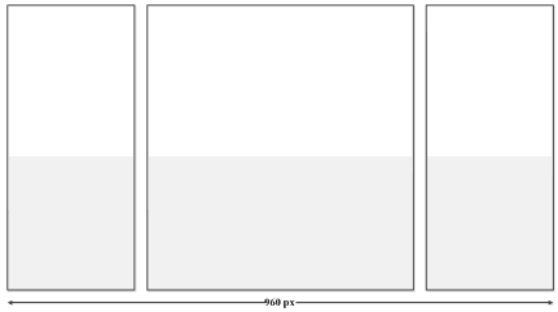
5.2 Guidelines

The guidelines define the fundamental steps/criteria to be taken/applied when developing an e-learning system for the blind and the visually impaired. The guidelines define 9 criteria which should be taken into consideration when designing an e-learning system.

5.2.1 Criterion 1 – HTML row and column design

The majority of web pages have only 3 columns (left, main and right) and 2 rows (header and footer), which poses problems for users as they navigate the page.

The design should be based on 3 columns as shown in Figure 1.



[Fig. 1] HTML column design

The columns should be of proportional width and contain predefined elements such as:

- First column 1/4 of total width – menu
- Second column 2/4 of total width – content
- Third column 1/4 of total width – additional functionalities.

The left column is reserved strictly for the main links of the web page, and tree menus or drop down menus should be avoided.

5.2.2 Criterion 2 – Keyboard shortcuts

An analysis of the systems currently in use indicates that each system has its own predefined shortcuts, which does not allow for efficient use and requires time to learn the various shortcuts.

Keyboard shortcuts should be standardized, so the following 6 basic shortcuts are recommended for navigating the website:

1. Home page – CTRL – ALT – H(ome)
2. Content search – CTRL – ALT – S(earch)
3. Top of page – CTRL – ALT – T(op)
4. Go to menu column – CTRL – ALT – L(eft)
5. Go to content column – CTRL – ALT – M(iddle)
6. Go to additional functionalities column – CTRL – ALT – R(ight).

The CTRL-ALT combination was defined in order to avoid overlap with existing shortcuts employed by operating systems and application solutions (MS Office, Inter-net browsers and more). It is also not possible to simply use a letter shortcut (e.g. the S key), because in certain cases the user would not be able to navigate the web inter-face in the necessary direction (e.g. when entering data in a search field).

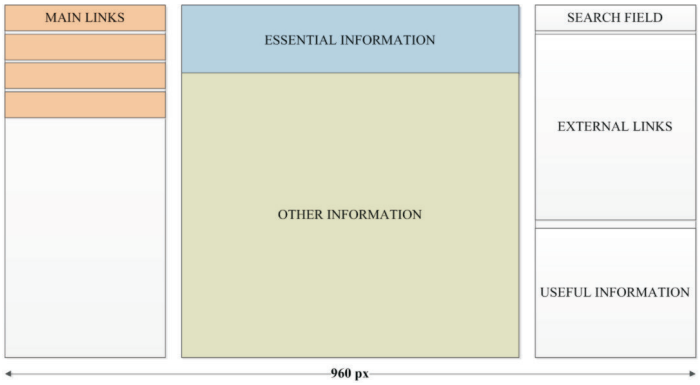
Navigating columns is based on a sense of orientation, so that the user can recognize the layout of the elements on the screen.

5.2.3 Criterion 3 – Direction of navigating a user interface

The direction of navigation should be from right to left. It is also important to limit the user to a maximum of two steps before obtaining the required information. If the user is navigating a column, navigation direction should be from top to bottom.

5.2.4 Criterion 4 – Information architecture

Information needs to be carefully selected and brief, as well as constantly available. It is also important to classify information into, for instance, essential, general and useful information. If the information is organized, users will always know where they are and what to look for. Essential information should be in the top part of the content column, while general information should always be found below. Useful information should be found in the right column, under the search field and external links (Figure 2).



[Fig. 2] Information architecture

Information which is found on the web page should not branch out into sub-information or in any other way.

5.2.5 Criterion 5 – Interface optimization

The interface should not incorporate "pop-up" or modal windows, nor should it employ flash animation. Only the necessary information should be provided. The interface should allow the visually impaired user to change the background color and the font, or to enlarge the font in accordance with WCAG 2.0 standards.

5.2.6 Criterion 6 – HTML tags

The website content (text, images, audio files) should contain descriptive tags. This is particularly relevant in the case of images, so that the description may be read by screen readers. Screen readers cannot decode documents in PDF, which is why the PDF icon with a brief description of the content should be used. The analysis indicates that ALT tags are often lacking, which renders the blind and the visually impaired unable to read the element. Descriptive tags should be clear and brief, without going into detailed descriptions.

5.2.7 Criterion 7 – Auditory feedback

The user registration field should employ an auditory warning for both correctly and incorrectly entered information. If information has been entered incorrectly, it is automatically deleted, with a focus on the field where the information has been entered incorrectly. Next, the user may reenter the information, having received an auditory warning. The auditory warning is defined through the standard auditory warnings of operating systems. A successful registration or login is also accompanied by auditory feedback.

5.2.8 Criterion 8 – Confirming data entry

Pressing the enter key does not execute the form action – it simply confirms data entry into the current input field. The form action is executed after the final input field. When the search function is used, the text needs to be entered and the enter key pressed in order to initiate a search, after which the focus shifts to the middle column, i.e. to the search results.

5.2.9 Criterion 9 – Accessibility evaluation

The accessibility of the website needs to be evaluated in accordance with the de-fined guidelines. It is also necessary to analyze accessibility using a validation tool recommended by www.w3.org.

6 Conclusion

The analysis of the e-learning systems currently in use at the University of Zagreb (Merlin and the LMS at the Faculty of Transport and Traffic Sciences) indicates a number of flaws with regard to accessibility to blind and visually impaired persons. The tools used in the analysis reported a large number of errors, although WCAG 2.0 recommendations were followed.

This paper defines the guidelines for adapting an LMS to blind and visually impaired users in terms of nine criteria. In addition to these criteria it is vital to guarantee the basic requirements of usability are met, such as:

- the exact position of elements on the page
- simple design
- the option of changing font size
- the option of changing background color (for the visually impaired)
- correct description of images
- adequate language support for letters
- in the case of video files, voice and text support must be included
- web frames have designated names
- standard web forms
- text cannot be in picture form
- if the web page uses visual verification (CAPTCHA), alternative auditory verification must be available.

The criteria were defined in the course of meetings with the users of web pages and LMS, of which there are 35 at the University of Zagreb, as well as HUPRT (the Croatian Association for the Promotion and Development of Typhlo Technology). These guidelines shall provide recommendations for their implementation within the University of Zagreb E-learning Strategy.

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