

Introducing Accessibility Features in an Educational Game Authoring Tool

The <e-Adventure> Experience

Javier Torrente¹, José Ángel Vallejo-Pinto², Pablo Moreno-Ger¹, Baltasar Fernández-Manjón^{1,3}

¹Dpt. ISIA Universidad
Complutense de Madrid

{jtorrente, pablom}@fdi.ucm.es

²Dpt. of Comp. Science, University
of Oviedo, Asturias, Spain

vallejo@uniovi.es

³Lab of Computer Science, MHG-
Harvard University

bfernandezmanjon@partners.org

Abstract—The introduction of new technologies in education raises accessibility issues, which can endanger the universal right to education for students with disabilities. Moreover, in education there is a shift to provide more dynamic and interactive content to the students and video games have been proposed to promote the development of new skills. In this paper we discuss the main challenges of introducing accessibility in game educational software and how they are being addressed within the <e-Adventure> authoring tool for educational games. The goal is to turn <e-Adventure> into a holistic solution for the development of accessible educational games.

Keywords—accessibility, <e-Adventure>, e-learning, distance learning, game authoring tools, game-based learning, online learning, videogames.

I. INTRODUCTION

During the last years new technologies and media have been proposed for education in order to prepare students for the challenges that this changing society demands. In this regard one of the proposals is to provide more dynamic and interactive content for students such as video games, which have been pointed out because of their potential as learning tools [1].

As the academic interest in video games as educational materials grows, several proposals have emerged to facilitate the creation of educational video games and simplify their application in educational settings. One of the proposals is using authoring tools to produce educational games (e.g. Game Maker or Unity) since they reduce the production costs and facilitate the game development by people who do not have a technical background [3]. In this manner video games are brought closer to the educational system as teachers and students can develop their own games.

However, the accessibility of video games is an open issue. This problem becomes more evident when the games are introduced in e-Learning environments, where the accessibility of traditional content is reasonably covered by initiatives that facilitate access to the Web like WAI (which includes well-know lines of work such as WCAG) and assistive technology that facilitates access to most types of educational content (e.g. AdobeTM PDF documents).

The purpose of this paper is to analyze the challenges posed by the introduction of accessibility in educational video games. From this analysis we present how these problems are being addressed in the <e-Adventure> platform

for the creation of educational *point-and-click* games [4]. The aim is to provide an accessible video game authoring tool that produces accessible games without requiring a significant increase in the development cost.

II. ACCESSIBILITY IN VIDEO GAMES

Most video games are not fully accessible for people with disabilities. This issue may be related to a lack of awareness of game developers and an unclear return of the investment. The development of many accessibility features require technical solutions that increase the total development cost (e.g. speech synthesis, voice recognition). This issue is even more relevant in the field of educational games, where budgets are more constrained and accessibility is even more important. Therefore it is necessary to find new ways of reducing the cost of improving games accessibility.

Nevertheless there are different approaches to improve the accessibility of video games [5]. Focusing on hardware, an approach is to develop game pads adapted for people with different disabilities, new interaction devices such as systems that track the movement of the eyes or the head, or special keyboards. There are other cases where games are made compatible with support devices or even integrate their own support tools such as screen readers, magnifiers, speech synthesizers, voice recognizers or virtual keyboards.

Another approach is to provide a multimodal design of the game interaction, providing various input and output channels for interacting with the game. For example it is typical to combine images with captions, sounds and voices [6], include support for voice commands [7], etc. However, such approaches are often developed ad-hoc, providing particular solutions for each game, which makes difficult to reuse efforts. More general solutions, including frameworks and other development tools are needed, especially for small projects.

A general accessibility requirement for video games is to let the player configure some of game settings. Certain visual, hearing and motor problems can be dealt with by making minor adjustments in the game such as the size of the texts, the time thresholds for replying the attack of an enemy, etc. [5].

III. THE <E-ADVENTURE> PLATFORM

<e-Adventure> is an authoring tool for creating educational video games and simulations [4]. The aim of <e-Adventure> is to facilitate the development of video games

for people without a technical background (i.e. mainly teachers or students).

As a strategy to reduce the development costs and the complexity of the authoring tool, <e-Adventure> focuses on the genre of *point-and-click* adventure games, like the *Monkey Island™* or *Myst™* sagas.

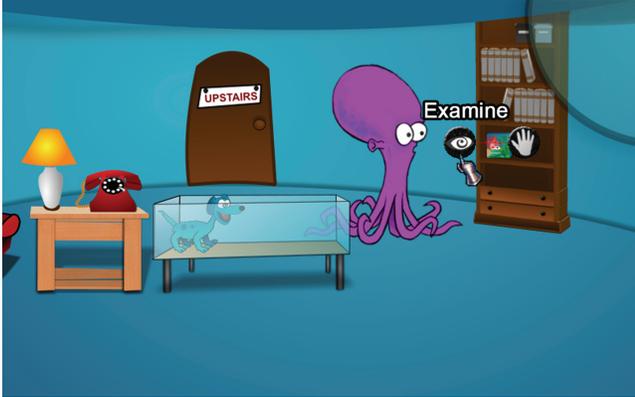


Figure 1. Screenshot of a third-person <e-Adventure> game. It shows a two-button contextual menu with the available interactions over an object. The cursor changes when the mouse is over an interactive element.

Therefore <e-Adventure> games are composed by scenes (made up by a background image) which are interconnected (as defined by the game author) resulting in a 2D navigational environment. In this environment the player has to solve the challenges that game author defines.

In <e-Adventure> games, to discover the interactive elements players need to explore the scene using the mouse. When the mouse slides over an interactive element the cursor changes and a short text is displayed, providing in this manner visual feedback (Figure 1).

When players click the mouse on an interactive element a contextual menu appears, including the different actions that can be performed with it (Figure 1).

<e-Adventure> games go through different states according to the content being displayed. For example, there are different game states for displaying videos, slide scenes, the game menu or interacting with the game world (normal play). In each state the interaction is adapted to the type of content provided. For instance, when slide scenes and videos are shown mouse clicks are used to control the reproduction of the content.

All the aspects of a game can be configured using the game editor. This editor follows the WYSIWYG principle (What-You-See-Is-What-You-Get) and does not require any explicit coding or scripting to make games.

IV. INTRODUCING ACCESSIBILITY IN <E-ADVENTURE>

A. Multi-Modal Interaction Solutions for The Games

Currently <e-Adventure> has been powered with four interaction profiles for different stereotypes of users: *Unknown Disabilities* (UD), *Limited Vision* (LV), *Blindness* (B), and *Limited Mobility* (LM). To deal with this diversity three different input layers have been implemented: a Mouse

Interface Layer (MIL), a Voice Interface Layer (VIL) and a Keyboard Interface Layer (KIL).

Users categorized as UD are supposed to have no serious handicaps in the use of any device. UD users will use classic *point-and-click* interaction. The Mouse Interface Layer deals with this type of interaction.

For Limited Vision (LV) users the graphic interface is adapted. A high contrast rendering mode is enabled, which combines automatic adaptations and the use of asset resources specifically designed for the needs of this stereotype of users.

Limited Mobility (LM) or Blind (B) stereotypes profit from the Voice and Keyboard Interfaces, which provide new interaction mechanisms. LM Users are expected to have problems in using a computer mouse can interact with the game through voice commands using the VI. Blind users (i.e. those that have a severe visual disability and are used to interact with computers using the keyboard) will make use of the KI.

Both Visual and Keyboard Interface Layers recognize the same command patterns in natural language but using different input devices. A typical command matches the structure Verb + Article (optional) + Element + Conjunction (optional) + Element2 (optional). For instance, valid commands are “Describe the scene” or “Use key with locker”. However, frequent commands are usually mapped to shortcuts in the keyboard for Blind Users instead of using text sentences (e.g. skip is translated to Ctrl+Right arrow). Table 1 provides some examples of valid commands.

Table 1 Examples of commands for B and LM

Action	B interaction	LM interaction
Skip reproduction	Ctrl+Right arrow	"Skip"
Pause reproduction	Space	"Pause"
Exit game	Esc	"Exit"
Obtain a description of the scene	Describe the scene	
Grab an item	Grab item	
Get description of an item/character	Name of item/character	

Additionally <e-Adventure> games are also enhanced with sonorous feedback for Blind Users, including a speech synthesizer that transforms all text lines that present information in the game to voice and descriptive sounds (e.g. beeps) for common actions (e.g. enter/exit the game menu).

To support voice recognition (for users with Limited Mobility) and text-to-speech (for Blind Users), we use Microsoft’s Speech API (SAPI 5.4) which is wrapped with the Com4J library that allows invoking Microsoft’s COM interfaces from Java code.

Although users with cognitive disabilities have not been considered explicitly as an stereotype, <e-Adventure> also provides some support for this type of disabilities. <e-Adventure> includes a game adaptation engine that can modify the game experience according to characteristics of the player (e.g. by skipping some initial levels, avoid puzzles that are too challenging, etc.) [12].

All these accessibility features can be introduced in the games using the game authoring tool, which reduces the cost of introducing accessibility in educational games.

B. Configuring the Accessibility Features with the Editor

Our first approach to the introduction of accessibility in <e-Adventure> has focused on the games. As we describe in [11], once the game is designed the author of the game can turn on/off, a set of input and output modules and other support tools that are already bundled in the platform.

Moreover, in this menu we also include the options that allow the configuration of the accessibility features of the games, as described in section IV.

The challenge is to find an appropriate balance between flexibility and readiness to use for the accessibility solutions produced. On the one hand the systems should be flexible enough to cater for the broadest possible audience. Moreover, these solutions should be adaptable to fit different games, which poses an additional challenge (accessibility is introduced at platform level instead of at game level). On the other hand, the more flexible the solution is, the more effort is needed to be configured.

For this reason, in <e-Adventure> we have tried to minimize the number of accessibility parameters that are configurable.

The high-contrast mode, which is oriented to Limited Vision (LV) users, is performed mostly automatically. Contrast is increased by applying special filters to the background of the scenes, items, and characters. Element size is increased to improve ease of recognition. However, the editor allows game authors to introduce high contrast version of the images to deal with particularities of each game. To deal with needs of users with motor cognitive disabilities <e-Adventure> allows configuring some game parameters, like the double click gap. In addition features like text-to-speech or voice recognition can also be enabled by just activating a check box.

V. CONCLUSIONS AND FUTURE WORK

The introduction of new technologies in education must always take into account the needs of students with disabilities. There are still many open accessibility issues to be addressed to introduce highly visual and interactive technologies in the educational system in an inclusive manner. We have addressed these accessibility problems in the video games by introducing accessibility features in the <e-Adventure> platform.

The introduction of accessibility in an authoring tool as <e-Adventure> raises two different challenges. First, to make accessible the content the tool produces (i.e. the games). Second, to minimize the extra cost of introducing accessibility in the games by including easily configurable features in the platform.

Despite the work done, the methodologies and solutions proposed have various limitations. On the one hand, the introduction of accessibility in <e-Adventure> has focused on a small subset of primarily visual disabilities. Next

versions of the platform will pay special attention to hearing impairment, motor and cognitive skills.

On the other hand, <e-Adventure> is a multiplatform tool that can be run on Windows, Mac, Linux and even on the Web (only the games, not the editor). From a technical perspective, it is still uncertain how to develop accessibility for Java applications that run on different systems using free and open source solutions. Therefore, accessibility features only run on Windows and other approaches should be considered for other platforms.

One of our lines of future work is the generalization of our approach to other tools and paradigms. Currently we are evaluating the usability of the interfaces proposed in the context of the INREDIS I+D project (www.inredis.es).

ACKNOWLEDGMENT

The Spanish Committee of Science and Technology (TIN2010-21735-C02-02) and the Ministry of Industry (TSI-020110-2009-170, TSI-020312-2009-27) have partially supported this work, as well as the Complutense University of Madrid and the Regional Government of Madrid (research group 921340 and project e-Madrid S2009/TIC-1650), and the PROACTIVE EU project (505469-2009-LLP-ES-KA3-KA3MP) and the GALA EU Network of Excellence in serious games (FP7-ICT-2009-5- 258169). Special thanks to our colleagues from Technosite (ONCE group).

REFERENCES

- [1] K. Squire, "Video Games in Education," *International Journal of Intelligent Simulations and Gaming*, vol. 2, Oct. 2003, pp. 49-62.
- [2] M. Overmars, "Teaching Computer Science through Game Design," *Computer*, vol. 37, Apr. 2004, pp. 81-83.
- [3] J. Torrente, P. Moreno-Ger, B. Fernández-Manjón, and J.L. Sierra, "Instructor-oriented Authoring Tools for Educational Videogames," *ICALT'08*, Santander, Spain: IEEE, 2008, pp. 516-518.
- [4] J. Torrente, Á. Del Blanco, E.J. Marchiori, P. Moreno-Ger, and B. Fernández-Manjón, "Introducing Educational Games in the Learning Process," *EDUCON 2010*, Madrid, Spain: IEEE, 2010, pp. 1121-1126.
- [5] K. Bierre, J. Chetwynd, B. Ellis, D.M. Hinn, S. Ludi, and T. Westin, "Game Not Over: Accessibility Issues in Video Games," *HCI'05*.
- [6] N. Röber and M. Masuch, "Playing Audio-Only Games: A Compendium of Interacting with Virtual, Auditory Worlds," *DiGRA 2005*.
- [7] S. Targett and M. Fernström, "Audio Games: Fun for All? All for Fun?," *9th International Conference on Auditory Display*, 216-219.
- [8] O.E. Hetzroni and B. Shrieber, "Word Processing as an Assistive Technology Tool for Enhancing Academic Outcomes of Students with Writing Disabilities in the General Classroom," *Journal of Learning Disabilities*, vol. 37, 2004, pp. 143-154.
- [9] I.A. Doush, E. Pontelli, D. Simon, S.T. Cao, and O. Ma, "Making Microsoft Excel™ Accessible: Multimodal Presentation of Charts," *ASSETS'09*, Pittsburgh, Pennsylvania, USA, 2009, pp. 147-154.
- [10] Z. Wang, B. Li, T. Hedgpeth, and T. Haven, "Instant Tactile-Audio Map: Enabling Access to Digital Maps for People with Visual Impairment," *ASSETS'09*, Pittsburgh, 2009, pp. 43-50.
- [11] J. Torrente, Á. Del Blanco, P. Moreno-Ger, I. Martínez-Ortiz, and B. Fernández-Manjón, "Implementing Accessibility in Educational Videogames with <e-Adventure>," *MTDL '09*, Beijing, China: ACM Press, 2009, pp. 55-67.
- [12] P. Moreno-Ger, P. Sancho, I. Martínez-Ortiz, J.L. Sierra, and B. Fernández-Manjón, "Adaptive Units of Learning and Educational Videogames," *Journal of Interactive Media in Education*, vol. 2007, 2007.