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Accessible and Inclusive Virtual World for children with special educational needs

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***Abstract*—There are many projects related to software products targeted to children with special educative needs, but almost all of them are focused only on some kind of disability, ignoring all the others. In other cases, hardware and software requirements and expensive distribution models become in access and usage barriers for population with lower levels of income. This project presents the starting stage of a virtual world platform accessible for all kind of disabilities with a distribution and participation model based on the concepts of free software.**

***Index Terms*—Special Educational Needs, Free Software, Virtual Worlds, Inclusion, Accessibility.**

I. INTRODUCTION

The scientific method in pure research instructs the researcher to consider himself as an abstract being, carefully isolated of the object of study. On the other hand, in applied research there is a feeling of hurry for producing a change in the real world (to solve a concrete problem) and the researcher becomes another part of the problem, because his resources and capabilities will limit directly the scope of the solution to implement. In this project the base is a holistic vision of a specific problematic: the difficult to find software for children with special educational needs that meet at the same time the requirements of being inclusive and accessible, trying to understand both the reasons that causes that this kind of software is not attractive as product for commercial developers and also the reasons why it is hard to produce this software from non-profit and academic groups. It finishes proposing a framework for a virtual world for children with special educational needs based on the principles of Free Software as a way to overcome those limitations, grouping distributed development and research efforts and reaching the users who really need it.

II. THEORETICAL FRAMEWORK AND STATUS OF THE ART

A. Accessibility and Usability

Accessible Software is the software that can be used by users with different functional requirements. To develop this kind of software is usually more expensive and difficult than non-accessible alternatives. [1] mentions as reasons the inherent difficult to adapt last-generation technologies (like 3d-graphics) to accessible versions, the diversity of the kinds and degree of disabilities between users and the need to work in multidisciplinary teams that increases costs and complexity of project management.

The effort to reduce the complexity of this problem had produced a set of accessibility standards, especially for web technologies, like the WAI recommendations from the W3C [2], the IMSACC from IMS [3] and the section 508 in USA [4]. These standards and recommendations become concrete through it implementation in software frameworks and libraries, and tools designed to validate the degree of compliment. (Tawdis [5], Google Chrome Accessibility Tools [6], Web Accessibility Evaluation Tool [7]).

B. Inclusion

It is paradoxical that the emergence of advanced technologies is generating a broader digital breach. This is caused not only to the lack of accessibility of many of these technologies, but also to the fact that they usually have higher hardware requirements, or are based on expensive business models that marginalize most of the population that really need those solutions. In a world where every day more and more processes move to virtuality, increasing the access barrier to technologies increases the barrier to life opportunities. Some researchers propose strategies and recommendations for teachers to be able to use technologies as facilitator instead of an obstacle [8]. But an inclusive solution must recognize the existence of these limitations, further away from the logic of the markets.

C. Virtual worlds for therapy and education

Virtual worlds are one of those last-generation technologies that have a big educational and therapeutic potential [9], but unfortunately they present big challenges from the accessibility and inclusion point of view. Virtual worlds had not been widely understood and adopted within the set of daily tools of teachers and therapists, in part because the mentioned accessibility and inclusion problems, but also due to challenges related to Instructional Design [10].

D. Unified Design for Universally Accessible Videogames

Based on the concept of Unified Interfaces, [12] defines a design methodology for "Universally Accessible Videogames". That methodology is based on an iterative model and has as a central component the idea of abstracting game tasks in a way that they can be described independent of the mechanisms employed for a particular user. To express game tasks in an abstract way allow the isolation of the game design from the interaction components. A next step in this methodology is to create lists of possible interaction mechanisms for each one of the tasks (Polymorphic

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specialization with Design Alternatives), given the option to the user to select the set of interaction mechanisms that best fit his functional requirements. Another very important contribution of the methodology is to recognize the need of incorporate in early stages the feedback of end users and expert users.

E. Parallel Game Universes

Like most of new technologies, Virtual Worlds make strong use of real time communications between multiple users. Online communication (and online gaming, for this case) is a highly attractive feature for users live too far away from educational or therapeutic centers, or that face challenges for transportation either due to the nature of their disabilities or the lack of money. To access online communities also allow the creation of social networks and the development of an online identity, factors that can be used to increase the effectiveness of both therapeutic and educational processes.

Anyway, to create a virtual game environment that allows users with different levels of disabilities (or with no disabilities at all) to interact at the same level, without making the experience too hard for some of them and to easy (and boring) for others is a big challenge.

[13] Explores the idea of Parallel Game Universes: virtual spaces that while shared between a group of online users, are carefully adapted to functional conditions of each one of them, adding compensations and helpers to try to keep a balance in the gaming experience of the group.

In this way, in a game were the goal is to shoot at alien spaceships, a player with motor difficulties would receive help from the system like stronger shields, or more powerful bullets that those used for a partner with no disabilities.

F. Considerations

1. To design Universally Accessible software increments both the complexity and the costs of a project. Therefore, it is important to create frameworks, libraries and platforms that reduce the work of content creators, in order to incentive the development of this kind of projects.

2. The design methodology for The "Universally Accessible Games" provides a starting point for implementing a solution. The concept of abstraction of game tasks are applicable at Software Engineering level and offer a solution from the accessibility point of view.

3. Parallel Game Theory offers another component to the solution, from the point of view of inclusion.

III. DESIGN OF AN ONLINE PLATFORM FOR CHILDREN WITH SPECIAL EDUCATIONAL NEEDS BASED ON THE CONCEPTS OF VIRTUAL WORLDS AND FREE SOFTWARE

The idea of an online platform that offers an accessible virtual world to children with special educational needs is appealing because it may incorporate tools, assets and resources that would increase the speed of content development, reducing costs and therefore allowing groups without big budgets to embrace the production of educational and therapeutic activities for the community. The motivation for the community to participate is also reinforced by the fact that the platform is released under open source license.

Releasing the solution under an open source license also helps to alleviate the fact that development and operation of a virtual world platform that meets both the inclusive and accessible goals is a problem whose resolution demands resources that goes further than those typically available for single-person research projects. In some countries Universities gave priority to indexed publications rather than software as research products, so they are not really interested in assume the leadership of this kind of projects. And finally, the difficulty in monetizing the solution deters for profit groups.

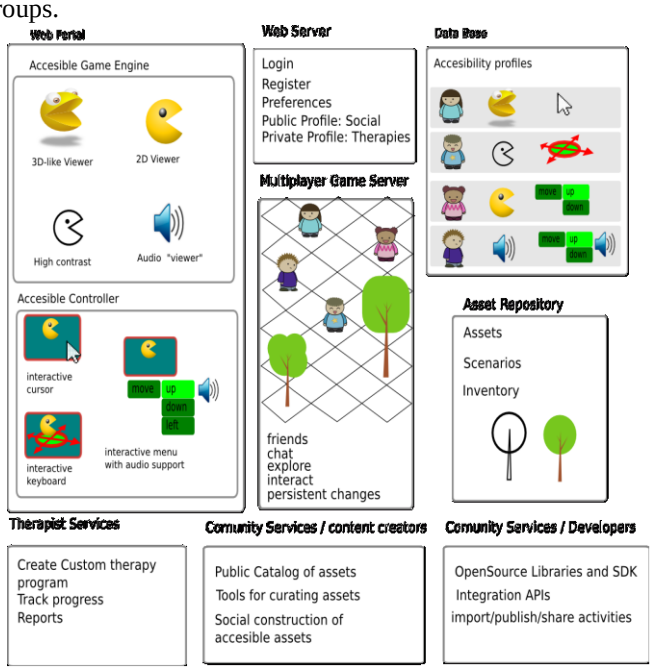

Fig. 1 General components of the platform

Fig. 1 presents the main components of the platform:

1. Web portal: It is easier to develop an accessible solution based on the existing accessibility standards for web and the frameworks and libraries that implement them. To develop a web based solution is therefore a strategic decision. A second objective is reached. If the solution is kept between the most common technologies: the ability to run in old (and cheaper) devices and the reduction of costs that comes from not having to worry by specific hardware details.

2. Accessibility profile: Web portal contains a section where users may specify their usability preferences (see figure 3). It is important to notice that the accessibility profile does not focus on specific kinds of disabilities: rather, it offers to the user a combination of software features that he can mix to fit his functional requirements. Some of the available features are: the kind of visualization (3d or 2d), level of detail (high detail, plain colors, high contrast), recorded narrations or screen reader support, use of mouse or keyboard, double

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confirmation to prevent false triggers on command executions, and so on.

3. Accessible Virtual World Viewer: Based on traditional web technologies (HTML5, canvas, javascript) the viewer presents a graphic version of the status of the world, at the same time that a WAI-ARIA live zone offers a narration through either the screen reader of the recorded narration system. Viewer can be used as an input element through mouse or keyboard, or being completely inactive to allow the interaction through the accessible controller.

4. Accessible controller: it is a special menu system that allows not only to execute actions but also to query the status of the world. Accessible controller also uses the WAI-ARIA live zone to provide auditive feedback, offers information about the options available and prevents false triggers thanks to the use of the double confirmation feature.

IV. TECHNOLOGIES USED FOR IMPLEMENTATION

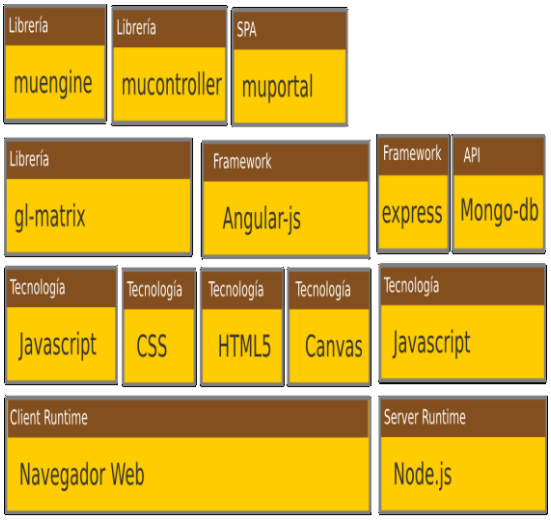

Fig. 2Used technologies

The Platform's prototype was implemented using a javascript full stack approach (Fig. 2). It means to use javascript not only at client side, but also at server side. The server is node.js, running the express framework on top of it, and the database is mongo-db, also accessed through a javascript API.

The server implements a RESTfull API (JSON-based endpoints over HTTP protocol), and in client side the browser executes a Single Page Application (SPA) built using the Angular.js framework. Other open source libraries are used as dependencies in the project.

V. DEVELOPED COMPONENTS

This section presents some screenshots of the different components developed for the prototype:

A. Accessibility Profile Editor

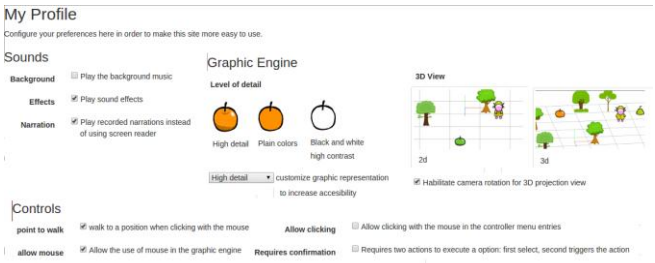

Fig. 3 Accessibility profile

The Accessibility Profile editor is presented in Fig 3. There are three sections (Sounds, Graphic Engine and Controls) that are fully WAI-ARIA compliant.

B. Accessible Controller

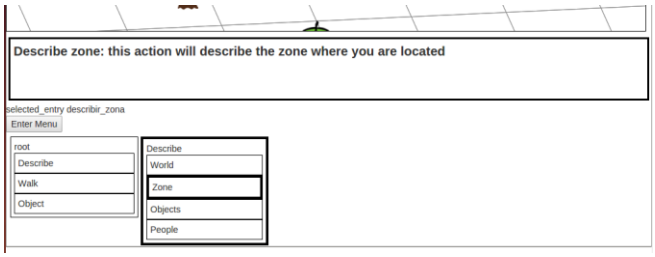

Fig. 4 Accessible Controller

Accessible Controller is presented in fig. 4. The black box with bold text at the top is the WAI-ARIA live zone where help text is injected to be read by the screen reader (or the pre-recorded narration system) while the user moves through the menu. Highlight of selected menu section and entry is provided. The user can manipulate the controller by using either the mouse or four keys of the keyboard. Moving with the keyboard into a new entry or section will trigger a description text, while a second trigger command will trigger the desired action.

C. Virtual World Viewer

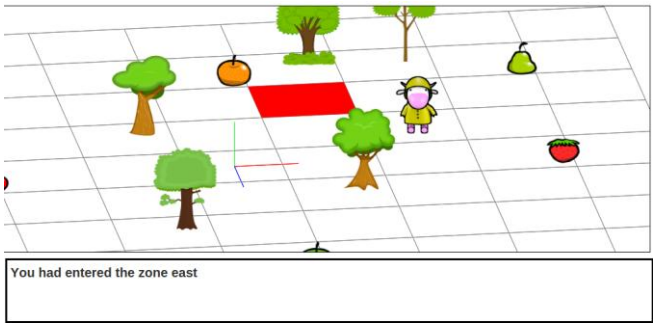

Fig. 5 Virtual World Viewer

The virtual world viewer is presented in fig. 5. It has enabled the "3D" mode and the full detailed textures, along with mouse support. Notice that this is not a real 3D view, the sprites are always 2D but the world itself has a 3D camera that can move and rotate in order to provide a pleasant 3D effect. In this way, the viewer does not need to rely on OpenGL or other real 3D technologies that may limit the goal of being an inclusive solution.

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VI. RESULTS

1. A first stage of the platform was implemented, with many of the important components presented for use in tests of concepts. These components are the Accessibility Profile Editor, the Accessible Controller and the Virtual World Viewer.
2. A usability test was performed with children with special educational needs, mostly with cognitive disability, and also with adult people, as a first attempt to detect usability barriers and to evaluate the effectiveness of the implemented support mechanisms. One of the conclusions of these preliminary tests was that the children feel more easy to use the "3D" view rather than the plain 2D view, because the 3D view gave them a better understanding of the extension and orientation of the world. It was also described as being more "nice" than the 2D view.
3. As part of the Universally Accessible Design Methodology, the project was also presented to experts in Accessibility and Inclusion, both national and international. There were obtained recommendations to improve specific aspects of the project and also there were expectative for a future development roadmap.

VII. CONCLUSIONS

Implementation of the Accessible Profile Editor increases the accessibility of the solution and becomes a first step towards the implementation of the concept of parallel universe games, because it offers different views of the world to each user.

The Accessible Controller is a good approach to the implementation of the concept of abstraction of game tasks, as proposed by the Universally Accessible Design Methodology.

The encapsulation of common functionality into an open sourced platform provides a starting point for reduce the complexity and costs of creating content both accessible and inclusive.

The selection of web-based standards and technologies benefits the project from reusing well established good practices and libraries, reducing costs of development while keeping a broad target of devices and platforms.

VIII. FURTHER WORK

It is important to invite the community to continue the development of the platform, by consolidating the core functionality, designing tools and workflows that allows the creation of open content, and find ways to raise the funds to run the internet infrastructure to offer the solutions to all the children.

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