Towards generalised accessibility of computer games

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Abstract. Computer games accessibility have initially been regarded as an area of minor importance as there were much more "serious" topics to focus on. Today, the society is slowly moving forward in the direction of accessibility and the conditions come to make new proposals for mainstream game accessibility. In this paper we'll show the main reasons why it is necessary to progress in this direction, then we'll explain how works standard computer applications accessibility and why it is not working in general with games. We will discuss the state of the art in this area and finally we will introduce our vision of future accessibility framework allowing games developer to design accessible games as well as assistive providers the possibility of developing Assistive Games Interfaces.

1 Introduction

Computer games have become an important part in child and youth culture, and most children, in developed countries, have considerable experience of such games. Additionally these games are used by a growing part of the population, including especially young adults (on average 25 years old, including 40% of women[1]) but the proportion of players is also growing in other age groups of the population.

A lot of people with impairment are excluded from the computer games world because of accessibility. Indeed games accessibility have initially been regarded as an area of minor importance as there were much more "serious" topics to focus on. Since the middle of the nineties, lots of works have been focusing on making office computer applications accessible, and it's a fact that nowadays word processor and spreadsheets applications are reasonably accessible as well as web browser and mail readers.

[1] TNS Sofres, *Le marché français des jeux vidéo* (The market of video games in France). afjv, November 2006.
`http://www.afjv.com/press0611/061122_marche_jeux_video_france.htm`

Today, as Zyda claims, *"the time has come to take computer games seriously, really seriously"* [1]. Indeed the mainstream commercial market for computer games and other multimedia products has shown an impressive growth in the last five years. Costs for the development of a game may reach the level of major movie productions, involving more than a hundred employees [2]. The expectation by games players of ever more impressive games has seen increasing development budgets, and with a more focused use of new technologies.

Academia and also R&D over the last years have started to focus on *"serious games"*. Leading experts speak of *"creating a science of games"* [1] with the goal of implementing games and game like interfaces of general importance for a growing number of applications and as a general trend in the design of Human-Computer Interfaces (HCI) [3].

In addition, general HCI is beginning to use concepts and methods derived from games as they promise an increased level of usability. Games and game-like interfaces are recognised as a means to implement educational, training, general HCI and web applications with usability and effectiveness. Particular examples of interest are:

- eLearning and edutainment which more and more implement or use didactic games [4]. As an example of this trend it should be noted that critical issues like mathematics and science education are approached with game-based learning infrastructures and edutainment to address the well known didactic problems in this domain. *"Games stimulate chemical changes in the brain that promote learning."* [5].
- Avatar based interfaces. We assist to a growing number of applications in such environments: for instance in France, real Job interviews have been organised in Second Life[2].
- Emerging Non Classical Interfaces (e.g. virtual/augmented reality, embedded systems, pervasive computing).
- A lot of Cultural Multimedia products, like Museum CD-Roms or DVD-Roms.
- Web 2.0
- Other software considered as inaccessible until today might come under accessibility discussions based on the principles, guidelines and tools developed for games and games like interfaces (e.g. simulation software, charts, virtual/augmented reality).

Then, even if it would be considered as questionable to use the limited resources that are available for research on accessibility to address problems of people with disabilities using games or edutainment software, the general evolution of HCI towards game-like interfaces compel us to also consider a "serious" look at games from the accessibility perspective, in order to keep pace with the general level of accessibility achieved over the last decades in standard HCI. When standard HCI changes also accessibility has to change and this is closely related to games.

[2] Linden Lab, `http://www.secondlife.com`

People with disabilities form one of those groups benefiting most from ICT. Indeed, Assistive Technology enables them in a lot of situations in their daily lives, at school as well as at work or at home, in mobility, etc. The possibilities offered to the by eInclusion makes a difference in the life of a lot of people. Therefore it seems important that children get used to using technology as early as possible. Computer games are often a good training for the use of AT, for children as well as for adults after accidents, diseases. In addition playing games contributes considerably in establishing and ameliorating the skills in dealing with HCI.

From a different perspective, new approaches towards therapeutic and educational games for people with disabilities; children can benefit a lot from the use of computer games for their psycho motor and cognitive development [6].

We can now find a few hundreds of specific games, which have been developed especially for various groups of disabled users, but actually:

- this number is very short regarding to mainstream games, and they are often limited to one language,
- these games are usually very specifically dedicated to a extremely small group of end users with little or no access to the mainstream market (based on their abilities)
- these games are often very simple or old fashioned (even if a few very interesting exceptions exist)
- an important amount of these games are driven by specific pedagogical and therapeutic objectives and, on the whole, not much fun.

The limited budgets dedicated to specific developments make it very difficult to propose specific games with the quality and the size of mainstream games, which limits the possibilities of gaming experience for those players. Because of this, games for people with disabilities tend to worsen the segregation of disabled people from the mainstream gaming community they are the only games that they can interact with. This situation is in contradiction with the general eInclusive principles of ICT and Assistive Technology.

Accessibility of games is a more complex problem than software or web accessibility in general. The first reason, which seems obvious but is very important, is that: Accessible games must still be games! [7] Designing games that work for players with disabilities is quite a challenge: an important research, practical and social issue that has to be carried out now. This research should lead to one goal: the accessibility of mainstream games. Several aspects have to be taken into account: to find out how to handle game interaction situations with alternative devices, to develop models allowing to make mainstream games compatible with these alternative devices, to write according guidelines, methodologies and techniques.

To give people with disabilities the chance to have access to multimedia games should be seen as a great challenge for better eInclusion and participation in society.

The main groups of people addressed by these accessibility issues are those who cannot use mainstream games because their disability prevent them to use a modality which is necessary for some kind of games, namely:

- People who cannot use the ordinary graphical interface, because they are totally blind or because they have a severe visual impairment (sight rated < 0.05) [8] ;
- People who cannot use or have limited access to ordinary input devices like keyboard, mouse, joystick or game pad due to limited hand dexterity ;
- People with cognitive problems who need support to better understand the scene and react properly (e.g. symbol, text, speech and easy to understand support) ;
- People with hearing problems or deafness not able to accommodate to sound based interaction modalities ;
- People with problems in reacting to a strict time setting of the game out of various functional, cognitive and also psychological problems.

2 Software accessibility

Today it is state of the art that people with disabilities can interact with the standard desktop/WIMP[3] based interface using Assistive Technology. Specific access software applications, like screen readers and screen magnifiers, alternative input devices, alternative information rendering – sound, text, signs, colour/size/contrast of objects, allow them to access to many computer applications. This is mainly the case, as mentioned above, for text based software: word processors, spreadsheets, mail clients, web browsers. The problem is that these access software applications are not able to access any software application whatever the way it has been developed. Indeed they need to collect accessible information from the applications to render it using alternative output modalities, or to control them using alternative input modalities.

In other terms, to achieve accessibility of software applications, it is necessary to have accessibility support embedded in the applications. During the last decade, accessibility frameworks have been developed and are available in the main environments. For instance, Microsoft has developed Microsoft Active Accessibility[4], to make their Windows Applications accessible, application developers have to implement the IAccessible interface[5]. There exist similar frameworks on Mac[6] and on Linux desktop environments[7]. Theoretical works can be cited too [9]. Furthermore specific development frameworks need to support accessibility, for instance Java[8] and Mozilla[9].

[3] WIMP: Windows/Menus/Icons/Pointers
[4] MSAA: `http://msdn2.microsoft.com/en-us/library/ms697707.asp`
[5] `http://msdn2.microsoft.com/en-us/library/accessibility.iaccessible.aspx`
[6] Apple accessibility: `http://www.apple.com/accessibility`
[7] Gnome Accessibility: `http://developer.gnome.org/projects/gap`
KDE Accessibility: `http://accessibility.kde.org`
[8] Desktop Java Accessibility
[9] Mozilla Accessibility Project: http://www.mozilla.org/access

It is not enough that applications respect accessibility standards. In most cases, content must be accessible too. For instance, in the case of a web site, the accessibility of web browser is necessary but the web contents must also be accessible. Graphical elements for instance must have textual alternatives, and this depends on the content itself. In that respect, the W3C launched the Web Accessibility Initiative to developed Web Content Accessibility Guidelines [10]. These guidelines indicate how to use each of the HTML tags to make a web site accessible. Accessibility of content has been developed in other content formats such as the proprietary PDF and Flash formats[10].

Of course there are still a lot of barriers in access to software and web content, but basically there are technical solutions asking for according political and practical measures to put this potential in place.

3 What is different in the case of games?

These accessibility solutions are working satisfactorily for standard desktop applications (WIMP based) but not for computer games. First the notion of working satisfactorily is a) not enough and b) not easy to define in that context.

Indeed, the results of a game can not be easily quantified, like in the standard case of classical desktop applications. In a word processing software, it is easy to measure the time needed by a user to write a document or to edit a document produced by a colleague. In a game we can as well observe if a player succeeds, and measure the time to finish a level or any case relevant for the game considered. But this is far not enough. Unlike others software, games have to provide special good feelings to players. There are probably some emotional factors to consider in the desktop applications, but they are usually not taken into account, or at least unless they affect the productivity. In the case of a game these factors are the most important.

Video images and audio messages contain emotional components and specific patterns which can easily be perceived and due to empathy can be experienced by the viewer and listener. For the same reason interactive video games are attractive and popular among the youth and adolescence. Empathic arousal has a strong influence on people viewing, listening and reading by forming their social response to the external events through mental estimation of the problem and simulation of possible solutions and actions [11, 12].

It has been demonstrated in numerous psychological studies that some emotions can motivate a specific human action and behaviour. The development of the emotional intelligence in youth depends on a social inclusion and personal experience which usually rely on observing others' actions and behaviours presented in a real life (the cultural *milieu*) and in the artificial situations disseminated by movies, television and video games [13–16]. Being deprived of access to information with emotionally rich content, blind and visually impaired children have experienced a significant emotional distress which can lead to depression and deceleration in cognitive development [17, 18].

[10] Adobe Accessibility Resource Center: `http://www.adobe.com/accessibility`

As we stated above: *Accessible games must still be games!* Visually impaired adults in work situation accept relatively big constraint on usability to be able to use the same software as their sighted workmates and to work on the same documents. This is not the case with children, especially playing. In other terms it is not enough to find a technical way allowing to access to all information needed in the interface, the result must be as interesting and as usable as the original game, and additionally it must be possible to succeed!

This helps us to understand that game interfaces are of a profound different nature than standard HCI and use their own technology (game engines). Usability and accessibility ask for freedom in time, speed, undo, mode of interaction,... It is a key criterion outlined by the W3C/WAI guidelines and software accessibility guidelines that the interface must not prescribe a certain interaction behaviour. But it is the core idea of games for realising immersion into a game, joy and setting up the gaming feeling to prescribe a restricted action and reaction behaviour and to force the user to be successful in this "reality". It seems that the more the player has to follow a strict behaviour, the more it seems that the game "takes the player into it" and puts immersion in place.

Therefore game accessibility goes beyond standard HCI and content accessibility measures. It must allow the prescription of behaviour by the system but it asks for alternatives and freedom of adaptation in the level of prescription and usage of modalities of interaction. If a mainstream game has put accessibility in place it is the role of adapted AT interfaces to realise immersion. Therefore it is inevitable to work on these adapted AT interfaces in game accessibility.

4 Game accessibility during the last decade

Even if a fair amount of games has been developed in this field during the last 5 years, today there are still very few games that are accessible (including specific games and mainstream games). Coming back to the year 2000, one could only find a very short number of games usable by disabled players.

4.1 Specific games

The first period that we identified is the period 2000-2005, that we will call the "basic studies". During this period we have seen the development of various games specifically designed for specific groups of people with disabilities. These kind of games are usually funded by foundations or non-profit organisations. Most of them are very nice for the group they were developed for but have little interest for mainstream, except maybe a few of the audio games. What is additionally of importance in the context of this proposal is that they demonstrate how to render various interaction situations with alternative modalities. This can be supplemented by the number of research papers about new uses of various modalities in the game play (Braille devices, haptic...).

The largest number of such games concerns audio games. Actually audio games include three different concepts in which the main play modality is audio.

The first meaning involve mainstream video rhythm games like Guitar Hero II. The second definition is related to artistic musical experiments. The third correspond to games which is based on sound environment (sound scenes, sound characters, actions) and can be played without vision, and therefore are accessible to visually impaired players (like interactive audio books, stories and tales): In 10 years, over 400 accessible audio games have been developed (which is very small as compared to video games).

The web site `http://audiogame.net` refers interesting interactive works. There exist a few visual audio games which can be very impressive and playable as well with or without sight. Terraformers [19] was developed with accessibility as part of the original concept of the game. On the other hand, AudioQuake [20] was developed as a research project to make a non-accessible game accessible.

A few tactile games can be found, that are games where the inputs and/or the outputs are done by tactile boards or by Braille displays, in combination with usually audio feedback. The use of Braille displays for gaming is only experimental by now. Some research is currently carried out in order to find models to represent a 2D space on a linear Braille display [21]. A few experimental games were designed in order to evaluate these models, for instance a snake game and a maze game. During the TiM project [22] (IST-2000-25298), a number of tactile games have been created or adapted from existing mainstream contents. Tomteboda resource centre in Sweden have published a report where they try to stimulate parents and educators to develop their own games using tactile boards [23].

[24] studied the possibilities offered by haptic technologies for creating new interactions usable by blind people. He worked especially with the Senseable Phantom. Then a number of papers explore the possibilities of using haptics in experimental games: [25–30]...

The outcomes of this period is that we can base our work now on a lot of studies on playing games in various situations of functional limitation and on the adaptation of computer game situations.

4.2 Setting up the foundations

The second period, ongoing since 2005, sees the emergence of the notion of games that work for all. This is declined in 2 aspects: game designed for all and accessibility of mainstream games. It is driven by the already mentioned fact that games and game like interfaces are recognised as important contributions to the next generation of HCI, eLearning and other applications.

The goal of games being developed under the title of designed for all is to give players with all different kinds of abilities or disabilities the opportunity to play these games. This requires a very advanced game setting and configuration. UA-Chess [31] is a universally accessible Internet-based chess game that can be concurrently played by two gamers with different (dis)abilities, using a variety of alternative input/output modalities and techniques in any combination. Access Invaders [32] is a designed for all implementation of the famous

computer game Space Invaders, with the target groups of people with hand-motor impairments, blind people, people with deteriorated vision, people with mild memory/cognitive impairments and novice players. The approach of [33] was to make an already published game accessible and demonstrate the feasibility and the effort necessary to fulfil this goal. It is based on an open-source implementation of Tic-Tac-Toe.

Games designed for all must be seen as examples of good practise, demonstrating that Universal Access is a challenge and not utopia. In this projects we have to admit that the various alternative access features to these games require more development than the rest of the game itself.

Following these experiments it became clear that the accessibility of mainstream computer games needed to be improved. We started to work on formulating Guidelines for the Development of Accessible Computer Games, covering a wide range of disability groups [34]. IGDA published a white paper on Accessibility [35], showing early signs of interest from the mainstream gaming industry.

5 What is needed now?

We have developed the reasons why computer game accessibility should be considered seriously. Then we have seen how accessibility works in the case of standard desktop applications and why current accessibility frameworks it would not work with games or game-like applications. In the previous section we have seen that a lot of works have been studying how to render different game situations using different kinds of alternative devices.

Players with disabilities need to use Assistive Technology to play accessible games. But contrarily to any other computer application, this must not take off the characteristics of these applications that make them games. It is not only the task which one fulfils with an application (e.g. with office/mail software) but it is the procedure of playing the game it self which is fun and which provides learning benefits. In other terms, games accessed with AT still must be games and due to this it challenges the usage of AT. Then increasing accessibility of games will mean developing a new generation of assistive software taking into account much more parameters than current AT has access to, via the existing accessibility frameworks: characterisation of information available (including ranking of importance regarding the current task to fulfil), relative importance of events, speed, etc.

These new assistive software applications, which we will call *Assistive Game Interfaces* (AGI) will not likely be unique for a specific kind of impairment (like today a screen reader allows to access any office application). Depending of the ability constraints, some could be dedicated to a specific game or a game engine, some would be dedicated to a kind of games and finally some others would be generic (covering a large range of games).

We could for instance imagine a "captioning application" allowing lots of different games to have captions when a character is speaking. On the other hand, for blind gamers, we could have specific AGI for text based games, another AGI

working with a specific game engine, and a third one dedicated to a popular car race (since in this case the interaction would have to be completely redesigned).

To achieve these goals, the AGI will need to collect information from the core of the game itself. Indeed most of the information needed cannot be efficiently processed automatically from the mainstream game (for instance the captioning information). We have seen that the existing accessibility frameworks are not sufficient to provide these AGI with the necessary information. This means that it is necessary to design a new Game Accessibility Framework (GAF). This framework will have to take into account the specific data needed by various alternative devices to work properly. To continue with the example of the Captioning application, this application will need access to the complete transcription of the texts spoken by the characters in the game. The Game Accessibility Framework will have to specify how and in what format.

The first steps to carry out the specification of the Game Accessibility Framework are (a) a typology of game interaction situations and (b) a characterisation of Accessibility in terms of functional requirements. From the study of these expected results, the specification of the GAF can be produced, including the data formats and exchange protocols to transmit information between game and AGI.

Now it is time to make a significant move. This implies some participation from assistive technology specialists as well as from mainstream games developers.

The proposed solution may seem not realistic but it has to be considered that:

- The state of the art shows that the technology is ready
- This solution will be the lighter for game developers (consider for instance the work that would be needed to add a "caption" option in a game, compared to the implementation of the access to texts that are already existing somewhere in the production process).
- the societal need for improving inclusion is growing in some leading countries (Northern European countries, Austria, Canada, Japan, etc) and the political pressure will necessarily follow, leading to laws and recommendations. We expect that this situation extends to the rest of Europe and North America, and to the rest of the world.
- the evolution of standard HCI towards game like interfaces will soon make these applications enter in the scope of existing laws

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