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Making the Mainstream Accessible: More than a Game

Matthew T. Atkinson

Research School of Informatics
Holywell Park
Loughborough University
Loughborough
Leicestershire, UK LE11 3TU
M.T.Atkinson@lboro.ac.uk

Sabahattin Gucukoglu

AGRIP
<http://www.agrip.org.uk/>
sebby@agrip.org.uk

Colin H. C. Machin

Department of Computer Science
Loughborough University
Loughborough
Leicestershire, UK LE11 3TU
C.H.C.Machin@lboro.ac.uk

Adrian E. Lawrence

Department of Computer Science
Loughborough University
Loughborough
Leicestershire, UK LE11 3TU
A.E.Lawrence@lboro.ac.uk

Abstract

Accessible gaming provides a means of social integration for disabled people. As the gameplay and technology gap with the mainstream narrows, more complex forms of interaction between players are supported. Some important challenges in providing accessible communication and coordination between players in multiplayer settings are discussed, as well as a number of fringe issues such as integration with online gaming communities. We also demonstrate the potential benefits of using the techniques developed for use in areas use in areas including education covering the potential benefits to both disabled and non-disabled users. The work is discussed within the context of other projects in this and related areas.

Keywords

Accessibility, Blind, Vision Impairment.

ACM Classification Keywords

H.5.2. User Interfaces: Auditory (non-speech) feedback; H.5.3. Group and Organization Interfaces: Computer-supported cooperative work; K.3.1. Computers Uses in Education: Computer-assisted instruction (CAI).

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Introduction

In recent years, a small but thriving “accessible games” market has emerged to provide computer games suitable for disabled (mostly vision-impaired or blind) people. As a result of this, the opportunity to experience some of the more advanced types of computer game technology and enjoyment that sighted gamers have taken for granted over many years has been opened up.

Academic research into incorporating accessibility and usability principles into games has become popular. Through the work of organisations such as IGDA [15, 22], AudioGames.net [5, 21] and OneSwitch [9], the mainstream games industry is beginning to investigate the feasibility and benefits surrounding accessible gaming.

This paper describes the work of the AGRIP project [4] — an effort to develop techniques for making mainstream games, tools and their communities accessible to blind and vision-impaired gamers that has been active since May 2003. This has resulted in “AudioQuake” — a version of Quake [14] that has been adapted for use by blind gamers. The approach taken by this project contrasts with other contemporary research [21, 22, 1] in the following ways.

Adaption — Whilst other projects often develop new game/engine platforms anew, this project modifies existing well-designed mainstream technology to improve its accessibility and usability for all. The goal is *not* to retrofit accessibility, but to show how properly-designed systems may be made accessible through the processing and rendering of information at separate levels.

Generalisation — An important aim is to use the project to develop a deeper understanding of accessibility barriers that can be used in the development of general techniques to deal with those issues. We hope to create “portable” solutions to accessibility problems, that can be used in other (academic and leisure) settings.

The rest of this paper focuses on providing online capability and development support, as well as proposing methods for providing improved access to other areas of education based on the techniques already developed by the project and others working in this area.

Online Interaction

In the first iteration of AudioQuake’s development, the focus was on providing low-level game accessibility thus giving the user the ability to navigate around their local environment [2]. One of the project’s ultimate goals, however, was to provide accessibility to multiplayer game modes. This creates some extra challenges on top of those already encountered.

Global Information — Global, as well as local navigational information, must be imparted to the user (so that they may get a better idea of where goals related to the multiplayer game mode, such as the flags in “Capture the Flag” mode, are located).

Collaboration — To get the most enjoyment and success from team-based games, players must be able to communicate with each other. Allowing this communication without constantly interrupting play is important.

Web-Based Communities — External to the game itself, online communities can form. It is important to provide access for all users to such communities.

Our experience and that of other projects in solving these issues is discussed below. This section concludes with a discussion of how progress in the above areas has affected the ability of disabled gamers to collaborate and compete with their sighted counterparts.

Global Navigation

The main challenge of presenting global navigation cues is that of rendering abstract concepts such as game events. When, for example, sounds are attached to an object in the game world, the user will intuitively infer that the object is in their vicinity and, depending on how effective the sounds that describe the object are, what they can achieve by manipulating it.

The nature of global goals and events may be misinterpreted if a sound is simply attached to them. The user should be made aware of the distinction between information about their local environment and information about the state of the game world as a whole. Our solution and those of related projects are detailed in this section.

PRESENTING LOCAL AND GLOBAL NAVIGATION IN PARALLEL

One way around this problem is to incorporate global navigation into the gameworld in a *narrative* fashion. Under this scheme, events, characters or objects in the game can lead the player on through the world towards their goals. This approach often contributes to an increased sense of immersion on the player's part and has been successfully used in mainstream games such

as Half-Life [20] and accessible games such as Monkey Business [10].

This is not an appropriate form of navigation for many types of online game, however, because of their open-ended non-linear nature. Multiplayer-focused games use techniques such as varying the visual (and sometimes auditory) appearance of parts of the gameworld to act as landmarks. This feature was possibly inspired by the tendency of players in earlier online games to assign names to parts of the map so that navigation of other teammates could be better coordinated. It fits in well with the metaphor of navigation by GPS (which can also be made accessible, as [13] shows).

A combination of the above two approaches has been used in AudioQuake. A "waypoint marker" system was developed to enable players to produce a trail through interesting areas of the map. Distinct audio effects/filters were used to mentally separate these sounds from normal gameworld announcements. In addition, various locations have been tagged with names and differing environmental sounds to aid navigation via the conceptual map built up in players' memories. Informal user feedback so far indicates that, as could be expected, the latter approach is of more use in the case of fast-paced games such as AudioQuake.

MULTIMODALITY

So far we have only discussed techniques that use either audio or visual (for most mainstream games) techniques to aid navigation. There are many other possibilities when we consider the use of multimodal interfaces. Force-feedback, for instance, may be used

to give users a general impression of how close they are to a target, as well as what obstacles may lie ahead. In location-based games such as Demor [21], multimodality is taken to its logical extreme as the game takes place partly in the real world.

The goals of AudioQuake are to operate as fully as possible on low-cost commodity hardware. For this reason the software does not require the presence of devices such as a Braille display for rendering in-game messages, but it is capable of making use of one.

Extensive research has been carried out into the effectiveness of multimodal (specifically aural and haptic) feedback, such as the TiM project [1] and is out of the scope of this paper, but is mentioned here for completeness.

Collaboration

Many popular online gametypes (and collaborative workspace applications) are team-based. To include disabled people more fully in the world of online collaboration, the following challenges have to be solved: communication and coordination between users; appreciation of the relative position of users and understanding the strategic position of the team as a whole.

COMMUNICATION

Traditionally, text-based messages have been the way that players of first-person games communicate with each other. Such messages could be directed at everyone or the player's team, for example. This method has been used in AudioQuake, but poses the following usability problems (arguably some of these are applicable to sighted players too):

- Activating the console interfaces used for reviewing chat messages impedes the player's ability to move around the game environment (because the keyboard is used for movement and interaction with the environment).
- Using either the console or single-line text entry facility for sending chat messages presents the same problem.
- Chat and other announcement messages are rendered by a Text-to-Speech program. As sound is already the primary output interface of the game for many users, this can further overload this information channel, leading to errors and frustration on the users' part.

The first issue was tackled by adding extra keys (outside of those normally used for movement) that the player can use to quickly scroll through the history of chat messages. This was found to be effective. To combat the second problem, some players use VoIP systems externally to the game (as do many sighted gamers); however this only contributes to making the issue of auditory information overload worse.

For users that have access to Braille display hardware, approaches that employ other output devices to lessen the burden on the audio channel could be used. One such successful technique is that demonstrated by "BIRC", the accessible IRC client [12].

POSITIONAL INFORMATION AND STRATEGY

Though positional information is given for teammates and enemies surrounding the player – this is achieved through the use of a RADAR-like effect for beings in the

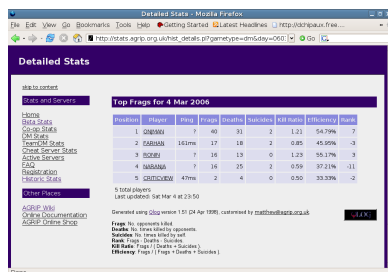


Figure 1: The (accessible) Stats and Servers site.

player’s visual field and is detailed in [2] – the overall strategic elements of the game are not presented.

Previous research [23] points out that people have differing abilities to coordinate themselves based on the perspective they are given in a collaborative application. Perspective in this case is fixed at first-person (from a graphical and aural point of view), which implies that lots of communication is required to achieve even simple collaboration. This is a trait of all first-person games but may well affect disabled people more dramatically than their sighted counterparts due to the communications overhead they have to deal with.

Issues like this one, in our experience, are the main causes of difficulty when sighted and blind players are playing together on a team, as the delay in communication causes a delay in blind gamers being able to react to instructions/information given by fellow team mates, thus a delay in their navigation to a position in the map where they can contribute to the game. The solution to these problems remains a question for future research.

Web-based Communities

Another common aspect to modern Internet-enabled gaming is that of online communities, often web-based, developing around the game and user-made modifications. Such communities are now prevalent, but often use inaccessible web-design techniques due to lack of awareness for potential disabled users. Part of the AGRIP project’s work has been to develop an accessible proof-of-concept for a player statistics tracking web application (shown in figure 1).

To combat some of the problems relating to the vast amounts of information available from sites in gaming communities, a number of techniques were developed to enable users to filter web-based documents for information most essential to them. This work was based on prior “Essentially and Proficiency” research [8, 7] and new extensions of it [3].

Meaningful Competition?

Remaining barriers to effective team collaboration have been briefly discussed. Surprisingly, the barriers to blind players competing directly against sighted gamers are not as great as one would imagine – though blind gamers are still at a definite disadvantage, scores in games have been close – on the order of 20% different between experienced blind and casual sighted gamers in a number of cases. This is mainly down to the simplistic nature of the interaction in “Deathmatch” as opposed to more team-oriented gametypes. The main issues preventing further progress seem to be:

Technical — The game does not currently provide a usable way for blind players to “look” up and down. This can be resolved in future iterations of the technology.

Input Speed — Blind gamers are stuck with the keyboard as an input device, which precludes them from being able to take advantage of the speed and shortcuts afforded by the mouse. Modern accessible games are starting to make use of peripherals such as force-feedback mice in an attempt to catch up to sighted gamers.

Fast Output Cognition — Visual information has a much higher bandwidth than the audio generated by

this and other accessible games. Decisions on which information the player needs have to be made in order to prevent the audio output channel from being overloaded with noise. Adopting more intelligent filtering and/or using alternative output channels could ease this problem.

The work so far could certainly be improved, but it has demonstrated that interaction between the blind and sighted in fast-paced virtual environments is a goal worth striving for.

Development Tools: Educational Integration?

Today there are few barriers to prevent people with sight loss from pursuing programming careers, however due to limited resources in the education sector, it can be hard to provide the tools necessary to teach programming to disabled students. Key skills for programming careers are therefore hard to acquire. At the same time, many sighted people have the opportunity to begin learning to program through the use of computer games, as such games often come with their own development environments. As is being recognised by the education sector [16, 11], games could be used as a way to introduce certain concepts in this (and other) areas.

Efforts to make programming accessible have been undertaken [17, 18] and have proved to be of great success, but do not appear to have entered the mainstream. We suggest this is because of their alien nature to many standard development platforms and, thus, the difficulty encountered when attempting to integrate them into a curriculum.

3D application development platforms such as Quake/AudioQuake provide a solution much closer to the norm. As AudioQuake *is* a mainstream game, it could quite easily be integrated into existing related courses, or courses that wish to teach high-level programming concepts in a more engaging style (as [6] demonstrates).

Techniques such as those used in [19] could be very useful in increasing the accessibility of the exercises (especially if the code has a complex layout), but during our informal testing, carried out using standard screen readers and Notepad, we did not encounter any problems in this area. This was partly due to the fact that the users were computer literate and the code used being written in a very consistent way, with the anticipation it would be used by blind people – real-world code could be quite different.

The hypothesised educational value of using games to teach programming concepts was tested at the 2005 International Computer Camp for Vision-Impaired People. Informal user feedback from participants (who were of normal University entrance age and were reasonably computer-literate) was positive; we found that it is practical to teach concepts such as procedural and event-driven programming using this approach. More formal testing should be undertaken to ascertain how far this technique can be used. So far, the benefits appear to be:

- Users engage actively with the tasks at hand due to the entertaining edit-test-re-edit cycle.

- Programming concepts such as object-orientation, virtual machines and design patterns can be explained in a familiar context to the user.
- Both disabled and non-disabled users can learn together, promoting inclusion.

Future Plans

This review of the current progress of the AGRIP project and how it fits in with (and differs from) other research has left a lot of questions open for future research to answer. Some of the main areas we hope to focus on in the future are:

- Improving and formally testing the methods for navigation and collaboration detailed here.
- Enabling better integration with sighted gamers.
- Generalising them and ascertaining how effectively they can be used in other areas.

Further issues that are being researched currently but are out of the scope of this paper are: low-level game accessibility issues; improving real-world mobility and spatial awareness; creating accessible 3D (level and other structure) design tools and developing the principle of "Essentially Tracks" [3] to improve access to educational and reference material.

Conclusions

This paper has presented work carried out in making online first-person gaming accessible to people with disabilities – specifically some form of sight loss. It has discussed techniques used to facilitate effective global navigation and team coordination in fast-paced

multiplayer games and compared them with other contemporary projects.

Informal user testing indicates that most of the techniques used are successful, as is evidenced by the popularity of AudioQuake. However, much work remains to be carried out in the future to improve the accessibility of this new genre of gaming and enable better integration with sighted gamers.

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References

- [1] Dominique Archambault and Dominique Burger. From multimodality to multimodalities: the need for independent models. In Lawrence Erlbaum Associates Constantine Stephanidis, editor, *Proceedings of the UAHCI'01 conference "Universal Access in HCI - Towards an Informative Society for All"*, pages 227–231, New-Orleans, United States of America, August 2001.
- [2] Matthew T. Atkinson. Making the mainstream accessible: What's in a game? In *Proceedings of the 10th International Conference on Computers Helping People with Special Needs (accepted; not yet published)*, 2006.
- [3] Matthew T. Atkinson. Opening up access to online documents using essentiality tracks. In *Proceedings of the International Cross-Disciplinary Workshop on Web Accessibility at the 15th International World Wide Web Conference (accepted; not yet published)*, 2006.

- [4] Matthew T. Atkinson and Sabahattin Gucukoglu. Accessible Gaming Rendering Independence Possible. <http://www.agrip.org.uk/>, May 2003.
- [5] AudioGames. AudioGames.net. <http://www.audiogames.net>, 2002.
- [6] Katrin Becker. Teaching with games: the minesweeper and asteroids experience. *J. Comput. Small Coll.*, 17(2):23–33, 2001.
- [7] Yangfan Cheng. Essentiality Mark-Up Editor to Address the Issue of Inaccessibility Using XUL. Master's thesis, Department of Computer Science, Loughborough University, September 2005.
- [8] Jatinder Dhiensa, Colin Machin, Francesca Smith, and Roger Stone. Optimizing the user environment: Leading towards an accessible and usable experience. In *Accessible Design in the Digital World Conference 2005*, 2005.
- [9] Barrie Ellis. Oneswitch: A resource of fun ideas and 'assistive technology', aimed at moderate to severely learning/physically disabled people. <http://www.oneswitch.org.uk>, 2002.
- [10] ESP Softworks. Monkey business. <http://www.espssoftworks.com>, 2001.
- [11] James Paul Gee. What video games have to teach us about learning and literacy. *Comput. Entertain.*, 1(1):20–20, 2003.
- [12] Thorsten Hampel, Reinhard Keil-Slawik, Bastian Ginger Claassen, Frank Plohmman, and Christian Reimann. Pragmatic solutions for better integration of the visually impaired in virtual communities. In *GROUP '99: Proceedings of the international ACM SIGGROUP conference on Supporting group work*, pages 258–266, New York, NY, USA, 1999. ACM Press.
- [13] Simon Holland, David R. Morse, and Henrik Gedenryd. Audiogps: Spatial audio navigation with a minimal attention interface. *Personal Ubiquitous Comput.*, 6(4):253–259, 2002.
- [14] id Software. Quake. <http://www.idsoftware.com/>, 1996.
- [15] IGDA. International game developers association. <http://www.igda.org>, 2005.
- [16] NESTA and EA. Futurelab. <http://www.nestafuturelab.org/research/teaching-withgames.htm>, 2005.
- [17] Jaime Sánchez and Fernando Aguayo. Blind learners programming through audio. In *CHI '05: CHI '05 extended abstracts on Human factors in computing systems*, pages 1769–1772, New York, NY, USA, 2005. ACM Press.
- [18] Robert M. Siegfried. A scripting language to help the blind to program visually. *SIGPLAN Not.*, 37(2):53–56, 2002.
- [19] Ann C. Smith, Joan M. Francioni, and Sam D. Matzek. A java programming tool for students with visual disabilities. In *Assets '00: Proceedings of the fourth international ACM conference on Assistive technologies*, pages 142–148, New York, NY, USA, 2000. ACM Press.
- [20] Valve Software. Half-life. <http://www.valvesoftware.com/>, 1998.
- [21] Eric Velleman, Richard van Tol, Sander Huiberts, and Hugo Verwey. 3d shooting games, multimodal games, sound games and more working examples of the future of games for the blind. *Lecture Notes in Computer Science*, 3118:257–263, January 2004.
- [22] Thomas Westin. Game accessibility case study: Terraformers - a real-time 3d graphic game. In *The Fifth International Conference on Disability, Virtual Reality and Associated Technologies*, 2004.
- [23] Huahai Yang and Gary M. Olson. Exploring collaborative navigation:: the effect of perspectives on group performance. In *CVE '02: Proceedings of the 4th international conference on Collaborative virtual environments*, pages 135–142, New York, NY, USA, 2002. ACM Press.