Accessibility in Virtual Worlds

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Abstract
Virtual worlds present both an opportunity and a challenge to people with disabilities. Standard ways to make such worlds accessible to a broad set of users have yet to emerge, although some core requirements are already clear. This paper describes work in progress towards an accessible 3D multi-player game that includes a set of novel tools for orienting, searching and navigating the world.

Keywords
3D, virtual worlds, accessibility, games

ACM Classification Keywords
H.5.1 Multimedia Information Systems: Artificial, augmented, and virtual realities; K.4.2 Social Issues: Assistive technologies for persons with disabilities; K.8.0 General: Games

Introduction
Virtual worlds have the potential to transform the way society operates. They enable their users to bring a sense of 'self' into their digital space, and provide real-time interaction with other participants in a shared virtual environment. They enable social groups and communities to form around shared interests, among individuals who are dispersed across the globe. They also have the potential to teach concepts that may be

difficult to grasp with traditional two-dimensional presentation.

However, these 3D environments are not easy for *anyone* to use at first. They require learning and practice. Controlling an avatar is more difficult than simply typing a command or pointing and clicking at items on a screen, and there are often many controls to remember. Users must manage multiple streams of visual and audio information presented over a dynamically changing background, and it is easy to become distracted or disorientated.

All of these simultaneous visual, audio, cognitive and motor demands represent potential barriers to users, especially to those with a disability. Because an avatar's behavior in the world is visible to others, the fear of looking clumsy or behaving inappropriately may also constitute a significant barrier to participation.

The detailed world model that is available for virtual worlds provides an opportunity to create tools that would not be possible in the real world, and could help users to participate successfully. This paper describes an investigation of virtual world accessibility being conducted in the context of a multi-player game. It outlines the core accessibility enhancements that are in development, and focuses in more detail on proposed approaches to three particularly interesting research problems: providing natural language descriptions of 3D environments; searching the environment; and navigating from place to place.

Related Work

Accessibility in virtual worlds has not yet received the same level of attention as web accessibility, but it is beginning to interest accessibility researchers, game design researchers, and game developers looking to broaden their audience. Gamers with disabilities are showing a strong desire for more accessible games as seen on websites that provide support, news, and discussion forums for gamers with disabilities [2, 5].

To guide and educate designers, guidelines have been suggested for the creation of accessible games [1, 3, 4, 8, 10] and accessible approaches to game playing and virtual environments are being developed [6, 9]. Games that are currently accessible for gamers with disabilities can be divided into two categories: 1) games designed specifically for disability groups [2], and 2) games intended for the general public that have been adapted to better suit players' needs [1]. While games in the first category may be in a better position to design specifically for players with disabilities, they lack the funding and resources needed to create the flashy, glamorous games found in Hollywood-style game development. They also have the drawback of isolating players from the social gaming phenomenon of massively multi-player games. As these games become more popular online, gamers with disabilities have a strong desire to play games that are designed for mainstream audiences: games that allow players both with and without disabilities to simultaneously play with friends and other people online [7].

This paper reports on research in progress that falls squarely in the second approach. The work, in cooperation with a game development team, incorporates new accessibility functionality into the game. The goal is to allow players with disabilities to play the game on an equal footing with all players.

Requirements

A survey was conducted with adult gamers who had a vision or hearing loss or a motor limitation that made mouse or keyboard use difficult, with responses from 21 individuals (19 male). These users noted specific problems with games and virtual worlds (e.g., lack of visual contrast, requirements to use multiple keys, and lack of captions for speaking characters). 46% of respondents play virtual world games with friends, and 38% play online with others. Their comments, together with existing guidelines and games, formed the basis for specific design decisions.

Given a commonly expressed view by non-disabled people that a virtual world would allow someone to be 'free' of their disability, it is important to note that respondents in the survey varied in their reactions to how they wanted to represent themselves in a virtual world – some wishing to portray their disability, while others wishing to portray themselves different than they are in real life. Some individuals wanted to choose based on the situation.

The Game

This work investigates potential accessibility designs in the context of a multi-player game. The game uses the Advanced Torque Game Engine (TGEA), an open source project, and involves both 2D and 3D interactions. These 2D interactions are based on graphical user interfaces (GUIs) that use typical GUI controls such as buttons and text boxes. Heads-up displays (HUDs) are GUIs that are not interactive, and are overlaid over the 3D world view to display information to the user. The game's features are typical of the activities and demands of other 3D virtual worlds. It is expected that techniques that are effective for this game can be generalized to these environments.

Building in Accessibility

Given the use of standard GUI controls within the game, core accessibility requirements from conventional GUI design must be addressed. Basic features currently in development include: customizable font size for all text in GUIs; high contrast and low contrast text options; keyboard navigation of all GUIs with speech and visual feedback; self-voicing capability for heads-up displays; keyboard-only and point-and-click-only modes of in-world navigation; the ability to remap controls; the ability to adjust control sensitivity and time-sensitive parameters; on-screen display of sounds and captions for spoken information; a user interface for personalization of these features; and training and help.

Beyond these core requirements, specific techniques are needed to help users to get oriented, locate objects and navigate through the environment. Many approaches are possible. The remainder of this section presents a suite of three interrelated tools that address these challenges.

Audio Description of the World

Perhaps the most obvious challenge in virtual world accessibility is how to express the visual world in audio, for those who cannot see the world, or desire an explanation to supplement what they are seeing. Even when the activity at hand does not require it, descriptions of the surrounding environment help to orient the player and provide a better sense of place and community.

One part of the solution is to supplement important visual effects with audio effects. This is especially useful for characters that move – the sound of footsteps can alert the player in a non-intrusive way that someone is approaching. The sound of the player's own footsteps can change with the type of terrain they are crossing.

Although a great deal of information can be provided as sound effects, this approach is difficult for novice users who have not yet learned the association between objects and their sounds. The accessible game explores the effectiveness of text-based scene descriptions by providing what may be the first working prototype of a general *look* function for describing a virtual world scene in words. Just as images on Web pages require a text description, for *look* to work, objects in the 3D world must also have text labels and descriptions. However, the design of these labels is challenging: The 3D object may be viewed from any angle or distance, may be partially occluded by other objects, and may have status that changes dynamically (for example a light may be on or off). Objects in virtual worlds are often designed with both a near and far appearance. As a starting point, the same model is applied to text descriptions, providing for each object a text name, a basic far description, a more detailed near description for objects, and status-dependent supplementary descriptions. These descriptions are angle-independent. In other words, the door of a building would be represented separately to the building itself, and have its own text description. Thus, it is only described when it is actually visible. For objects that have text on them, such as a sign, this text is included in the near description.

An important research question is how to select and prioritize the set of objects to be read. A balance must be struck between providing small details that could be important (such as a light shining on a faraway hillside), while not swamping the player with details of hundreds, or even thousands of visible objects. Objects in the accessible game are tagged with information designed to help the *look* algorithm to select and prioritize them. For example, an object may be tagged as being 'important' or 'dangerous'. Dynamic tags may also be useful, such as 'already-seen' or 'team-mate'.

Both tagging and labeling have the potential to affect game play. For example, players may be given instructions to look for a certain kind of object. The text label must be recognizable as describing an object of that kind.

Finding things

In the game, as in many virtual world situations, a player will often need to scan the current view for items of interest. This is usually performed by visual search. Assistance is useful for those with visual impairment, those who are accessing the virtual world from a mobile device with poor graphics, and also for novices.

Existing approaches to searching a view produce a list of search results for the user to navigate [9, 11]. It takes additional effort to relate a particular search result to objects in the view, and to orient the user's avatar towards an object they wish to approach.

The initial version of this accessible game explores an alternative form of search assistance that mirrors the incremental search approach used in word processors,

with a pair of *find* functions: 'find left' and 'find right'. When the first *find* command is given, the object ahead of the player is named. Subsequent invocations of the command name the next visible object to the left or right of the previous object, and orient the player (and their angle of gaze) towards that object. This makes it easy for the player to identify the object in the world, and to prepare to move towards it. The name and distance of the object, and orientation of the player, is spoken. If the found object is moving, the avatar turns to track that object until the player indicates otherwise. Future work will explore the use of find commands that use search terms, or focus on a specific kind of object.

Navigating to an object

Once an object of interest has been identified, whether by visual search, the *find* function, or some other mechanism, a user will often want to navigate to that object. A teleport function provides the most convenient way to get to a known location, but teleport capability can fundamentally change a game playing experience, and is not always appropriate. Nevertheless, some assistance with navigating through the world is of benefit to many users, especially those with visual or motor impairment. The accessible game proposes a *controlled walk* mode. A player initiates a controlled walk with a key press. When in controlled walk mode, the avatar is kept facing its target and walks in a straight line towards it. By default, the target is the object the player is facing. When the avatar reaches the target, the walk is automatically terminated without player action.

If an obstacle such as another player, a cliff, or a wall is encountered on the way to the target, the walk again is terminated. The player can also terminate the walk at any time by repeating the original key press or giving another movement command.

Audio feedback is provided to indicate when and why the controlled walk has terminated. If the walk ends at an obstacle, players can side step to try to get around it, continue (e.g. walk off the edge of a cliff), or start planning an alternative route.

The target of a *controlled walk* is often the last object reported by the *find* command, since this command orients the avatar towards each found object. However, targets do not necessarily need to be visible from the player's current location. Another command sets the player's intended destination as the current target. The user can also choose a location on a map as their target and initiate a *controlled walk* directly from the map. This closes the map and starts their avatar moving towards the target. This feature is intended to improve the usability of map information.

Targets can be moving objects, such as other players or enemies. Players can follow a guide by first *find*ing them and then starting a controlled walk towards them.

Current status and future plans

The game's core accessibility features and initial prototypes of the *look*, *find* and *controlled walk* tools are expected to be complete in February 2008. At this time, the game will be made available to the public. Hands-on sessions with children at a school for blind middle and high school students will guide further development of these tools. In the longer term, more formal evaluation of these and related tools will shed light on the strengths and weaknesses of each approach.

Summary

A set of core techniques for accessibility of virtual worlds is being developed, in the context of a multi-player game. Development is being guided by gamers with disabilities. While some accessibility requirements are clear, the best form in which to provide in-world orientation, search and navigation support remains an open question. This work contributes three novel assistive tools for virtual worlds that address these specific problems.

It is worth noting that the accessibility of the game described here is possible given the closed environment of this particular game. In the future, effective techniques for accessible game playing must be built into popular game engines (they currently aren't) and tools must be developed for providing the tagging and descriptions needed by accessibility features such as those piloted here.

The experience provided by these games will contribute to the eventual development of more general accessibility standards for virtual worlds. Such standards would identify essential features that could be built in to these environments, giving many more people the opportunity to participate fully.

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