Virtual World Accessibility: Directions for Research

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ABSTRACT
Virtual worlds may one day replace the internet but users with disabilities are often excluded from accessing them. This paper surveys recent research efforts in this area and points out areas for future research.

Keywords
Virtual Worlds, Accessibility, Visual/Motor Impairments

Categories and Subject Descriptors
H.5.2 [**UI**]: Voice I/O + Input devices and strategies

General Terms
Design, Measurement

1. INTRODUCTION
Second Life [1], World of Warcraft (WoW) [2] and recently MineCraft [3] are popular virtual worlds as they offer rich, three-dimensional environments for social interaction and which have experienced significant commercial success [4, 5]. These virtual worlds typically allow the user to control a digital puppet, called an avatar–with human capabilities, such as walking and gesturing–through a game-like third person interaction mechanism. Users can explore vast virtual worlds and interact with other avatars and objects.

Social interaction possibilities offered by Virtual Worlds (VW) significantly exceed what is possible with traditional Internet-based social interaction tools such as web forums, chat rooms, or messenger clients. Interaction with other avatars mimics real-life interaction as the avatar can perform a variety of activities such as dancing or playing games with other avatars. Virtual worlds could someday replace the internet [6].

Two different types of virtual worlds can be distinguished. (1) Game like virtual worlds such as WoW or Star Wars Galaxies [7] are modeled after role playing games with all the typical elements found in most games–such as enemies to beat, levels to attain, story line, goals to achieve, and possibility for the avatar to die. (2) Non-game like virtual worlds, such as Second Life, are different from game like virtual worlds because of their absence of such elements. Another difference is that Second Life is entirely created, owned, and maintained by its users which allows for completely different experiences depending on what place in Second Life is visited. Second Life is much more open ended than game like virtual worlds and the Second Life viewer acts more like a browser.

GAXID '11 Bordeaux, France

Figure 1: Screenshot of Second Life.

Unfortunately, a significant number of potential users are excluded from accessing virtual worlds because of a disability [8–10]. Moving from a strictly two-dimensional, predominantly text-based environment such as the Internet, to an entirely three-dimensional visual experience has raised concerns about accessibility [8, 9]. Three-dimensional environments require a higher degree of input than 2D environments. Controlling your avatar in WoW or Second Life typically requires at least use of a mouse–often surpassing input capabilities of the severely motor impaired, such as quadriplegics. Visually impaired who use screen readers are unable to access Second Life, as it lacks any textual representation that can be read by a screen reader [8]. Second Life has successfully drawn academic interest as a cyber learning environment due to its high degree of customizability [11–13]. To make the use of virtual worlds comply with section 508 of the US Rehabilitation Act [14], it is important to investigate how to make them accessible.

2. VW ACCESSIBILITY RESEARCH

A modified version of the Second Life viewer has been developed that allows for visually impaired to navigate their avatar using force feedback where different objects can be distinguished through different vibration frequencies [15]. This approach is restricted to only distinguish few categories of objects as vibration frequencies of different object categories have to be memorized by the user. A study [10] identifies some of the barriers visually impaired face when accessing Second Life. Different solutions such as the use haptic navigation are proposed [10, 16].

The **Guide dog** project [17] developed by the Virtual Ability Group [18] offers a virtual guide dog object that can be "worn" by a user's avatar. The guidedog provides a number of functions such as navigation and querying the environment through a chat-like interface. Feedback is provided using synthetic speech. Because it is integrated into the Second Life viewer, this solution allows for hearing in-game audio, but it may also require a sighted user to initially setup the guide dog object. Built-in speech synthesis typically does not allow for the same customizations as external screen readers.

Powerup [19] is a multiplayer educational game developed by IBM that supports various accessibility features for visual, motor, and cognitive impairments. Visually impaired users can play this game using built in self-voicing. Audio cues such as footsteps provide additional guidance. Four different islands are available with four different challenges to complete. Visually impaired users have the same options as sighted players and can issue a number of commands such as "look left" activated by key presses to get information about their environment.

IBM uses Second Life as a collaborative workspace on their own intraweb and is increasingly providing consultancy services to companies interested in doing the same [20]. IBM's Human Ability and Accessibility Center developed a Web-based interface called **Alphaworks** for Second Life [21] that can be accessed with a screen reader. This client provides basic navigation, communication, and perception functions using various hotkeys.

TextSL [22] is an accessible web interface for Second Life (See Figure 2) whose interaction mechanism has been inspired by multi user dungeon (MUD) games as these games are the precursors of virtual worlds. Because MUD's are entirely text based they are very accessible to users with visual impairments as they can be accessed using a screen-reader. TextSL allows its users to navigate their avatar, interact with objects and issue query functions using an intuitive natural language interface. The user can issue different commands, e.g., *describe, walk* as well as perform these commands on objects, e.g., *describe chair, move to chair.* An interpreter allows the use of prepositions and conjunctions such as, *"sit on the chair."* as well as mapping different verbs on the same internal command for an action, e.g., *move, walk, go* all map on the same internal command for navigating to a different location. TextSL offers collision free navigation as well as a mechanism that prevents overwhelming the user with audio feedback as virtual worlds contain large numbers of objects by synthesizing concise meaningful

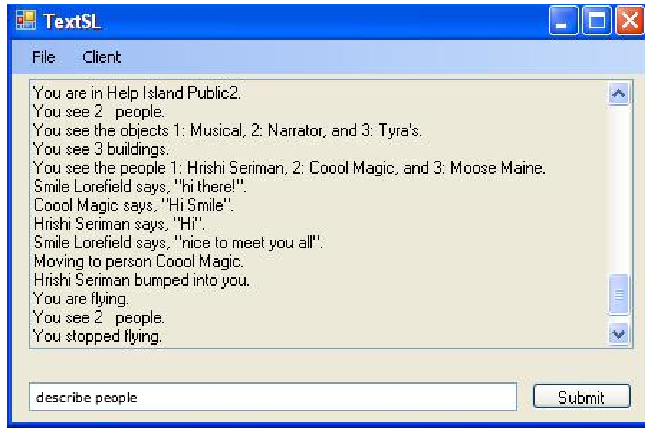

Figure 2: Screenshot of TextSL.

descriptions [23]. TextSL can be used with a screen reader as a standalone windows application or through a web interface, (`http://ear.textsl.org`) using built in speech synthesis, which also allows for access through a mobile device such as an iPhone.

A user study with eight screen reader users [24] found that interacting through TextSL, e.g, a command based interface is inherently slower than using the Second Life client, specifically exploration and object interaction is slower but communication can be performed with the same efficiency. Another important discovery is that at least 31% of the objects in Second Life lack a descriptive name, which is a significant barrier towards making virtual worlds accessible to users who are visually impaired as they rely upon these textual descriptions to be present. Two approaches have been identified that seek to improve the accessibility of Second Life by adding meta data for virtual world objects.

The **Alphaworks** client [21] provides a plug-in for the Second Life viewer, which allows users to manually add descriptive information to Second Life. Sighted users equip an annotation object to their avatar. When clicking on the objects in Second Life, a Web browser is invoked, allowing sighted users to enter information, such as names and descriptions of items or locations. This information is then saved in an external database and IBM's client can retrieve this data whenever a user encounters an object with missing meta-information. This approach can improve the metadata in virtual worlds but adding all this data manually for millions of objects could be a tedious and time-consuming task.

Seek-n-tag [25] is a game in Second Life in which sighted users find and tag objects using a scavenger hunt game. This game uses the Games-with-a-Purpose (GWAP) paradigm [26] to collect labels for virtual world objects where individual tagging efforts of different players are compared to derive a set of objects with accurate labels. This set of objects is used to train a classifier that can recognize 3D objects based on their composition, which allows for recognizing virtual world objects that do not have a textual representation; and to create a taxonomy for virtual world objects, which is used by the TextSL synthesizer [23] as to be able to compile concise descriptions of the user's environment without overwhelming the user.

3. DIRECTIONS FOR RESEARCH

Despite existing research efforts a number of research topics pertaining virtual world accessibility remain largely unexplored:

Non-Visual Impairments: with the exception of one research project, e.g., PowerUp, which offers some features for users with motor impairments, such as mouse only control, keyboard only control and reconfigurable keyboard options as well as closed captioning for hearing impaired players, most research projects have exclusively focused on users with visual impairments. Users with hearing impairments could previously interact in Second Life using text chat but are now excluded due to the increased use of voice over IP. Users with severe motor or cognitive impairments often lack the degree of fine motor control required to use input devices, such as mice, joysticks or controllers, or even a keyboard typically used to control an avatar in a 3D environment. In the most extreme cases these users use adapted input devices, such as an eye tracker [27] or single switch controller [28] that have been specifically designed to accommodate their abilities. Currently no access technologies exist that allows for navigating an avatar using a single witch input. A largely unexplored area is users with cognitive impairments. Cognitive impairments are complex and variable. The research challenges of understanding them and understanding how to accommodate their abilities are profound and although communities for users with cognitive impairments, such as autism [29], exist within Second Life, very little research has been performed in this area [30].

Interaction with Interactive objects: Certain objects, such as vehicles or billboards, can be made interactive using the Linden Scripting Language (LSL). Objects with simple scripts such as an ATM, provide text output and will allow the user to select a number of choices using keyboard input. More complex scripted objects such as a vehicle allow the user to drive the vehicle. When activating this object, the controls used to direct the avatar are temporarily mapped onto controls that allow for driving the vehicle. Other interactive objects, such as a chess game (See Figure:3), allow the user to click on a particular chess piece and move it to another location on the board. These types of interactions are difficult to access if you are unable to see or unable to use a mouse. Though TextSL allows for touching an interactive object, no textual output is provided as these objects typically exhibit behavior, which can only be perceived visually.

Content Creation: One of the most important features of virtual worlds is the ability to create content as Second Life and many virtual worlds are entirely owned and created by its users. Most commonly, content is created using a 3D modeling tool that is built into the viewer. Objects can be created by selecting a shape called a prim from a set of basic shapes and ''molding" this into the desired object. More prims can be added to this object and also different textures can be applied to the resulting object (e.g., to build a simple car one could select a box prim, scale this to the desired dimension, select a new prim such as a donut, scale this, and add it as a wheel to the box object). Media like graphics, video, and audio can be uploaded and embedded in the object. For users with disabilities to participate in

Figure 3: Interactive Chess game in Second Life.

virtual worlds, we must ensure they have the ability to be able to create 3D content. This obviously poses challenges for users with visual impairments, e.g., how can content be created using a command line interface? E.g., could users construct objects by simply typing, *"create cube"* or *"create tetrahedron"* which may be mapped onto existing Second Life functions to create objects out of prims? For users unable to use a mouse but only a switch input, creating 3D objects may be very elaborate and tedious if functions for creating objects have to be accessed through a scanning mechanism. For both types of impairments it may be easier and more efficient than rather construct objects out of prims to instantiate complete predefined objects from a library of objects where only a small number of basic manipulations are supported, e.g., *"set color green"*,

4. CONCLUSION

Virtual worlds are a promising and emerging technology with uses that go beyond pure entertainment. Until recently users with disabilities were excluded from accessing them, though virtual worlds could offer them opportunities for socialization and education. Because virtual worlds are increasingly being used in educational contexts it is important we explore how to make them accessible. This paper surveys existing research efforts in making virtual worlds accessible and outlines directions for future research.

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