Gazing into a Second Life: gaze-driven adventures, control barriers, and the need for disability privacy in an online virtual world

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ABSTRACT

Online virtual worlds such as Second Life and World of Warcraft offer users the chance to participate in potentially limitless virtual worlds, all via a standard desktop pc, mouse and keyboard. This paper addresses some of the interaction barriers and privacy concerns that people with disabilities may encounter when using these worlds, and introduces an avatar Turing test that should be passed for worlds to be accessible for all users. The paper then focuses on the needs of high-level motor disabled users who may use gaze control as an input modality for computer interaction. A taxonomy and survey of interaction are introduced, and an experiment in gaze based interaction is conducted within these virtual worlds. The results of the survey highlight the barriers where people with disabilities cannot interact as efficiently as able-bodied users. Finally, the paper discusses methods for enabling gaze based interaction for high-level motor disabled users and calls for game designers to consider disabled users when designing game interfaces.

1. INTRODUCTION

Online virtual environments are becoming increasingly popular as a means of interacting, chatting and spending time with friends and new acquaintances. Second Life, Entropia Universe, World of Warcraft and so on are part of the growing family of Massively Multiplayer Online Games (MMOG) and as computers and the internet become faster these worlds become more realistic and immersive.

Within these communities the users are represented as a virtual projection of themselves in the form of an avatar. The user can choose to appear as any shape, size, colour or other appearance that the game customisation allows, with the interaction taking place in a 3-dimensional world. The level of personal disclosure is entirely up to the user.

Depending upon the aim of the game, users are free to move around by walking, running or even flying. Objects can be created from simple shapes to complex virtual homes and even moving objects such as cars or spaceships. As these worlds are virtual, then almost anything creative may be possible. An example of such a world can be seen in figure 1. The screenshot shows our view of the world from a third person perspective, with our avatars back to us and the camera placed behind the avatar. Much of the scene is animated, including the trees and plants that move in the virtual breeze; running water can be heard coming from a fountain to the left although it cannot be seen from the current viewpoint; video advertising boards advising us on where we should visit.

2. WHO IS ME? THE VIRTUAL APPEARANCE OF DISABILITY

As well as being fun and engaging, virtual worlds allow users to do many things that they may not be capable of doing in the real world. Users are offered an environment that allows them to overcome normal physical limitations and do almost anything, human, or super-human. It is these very attributes that are now offering new opportunities to users who may have a physical disability - just as an able-bodied person can do anything in a virtual world, so may a person with a disability. However, there are differences to consider. A person suffering from a high-level spinal injury may use a wheelchair in the real world, but in the virtual world they may choose not to. The choice to disclose the disability in their avatar's appearance is the prerogative of the individual (Harrigan, 2007). Merely, looking at the avatars in Second Life it appears that most users, regardless of disability, choose to project an over-stylised version of themselves rather than a 'close-as-possible' appearance. Thus the virtual world becomes a very powerful tool for liberation and levels the abilities of able-bodied and disabled users alike. Harrigan uses a blog to discuss her own experiences as a paraplegic taking part within a Second Life community group called Wheelies. The group creator Simon Stevens, who suffers from cerebral palsy, explains his thoughts on the appearance of disability:

> *"The avatar is a powerful device in ensuring an inner self-identity. So for some disabled people, Second Life is an opportunity to escape from their impairment. Disclosure is optional and this "second life" often suits people who became disabled after birth. There is, however, a group of disabled people, including myself, who wish to appear disabled within Second Life. Within an environment which is perceived to be barrier free, it challenges the very nature of impairment and disability when someone chooses to appear disabled."*
>
> *– Simon Stevens (Harrigan, 2007)*

Figure 1. *'Second Life' created by Linden Labs – www.secondlife.com.*

2.1 The Barrier of Control

The typical method of interaction in these environments is via a combination of mouse and keyboard; with the keyboard being used for navigation and text entry and the mouse for controlling the camera and application control. Consider the scenario of a disabled user with a high level of paralysis. What if they are unable to use a conventional mouse and keyboard yet wish to appear as able-bodied as any other user in the virtual world? They are now presented with a barrier of how they might control their avatar rapidly and effectively so as not to appear as if there are difficulties with computer control. Appearance is only one requirement of avatar realism. Even if the avatar appears able-bodied, it will be judged on how interactive and believable it behaves (Romano, 2005). An avatar being controlled by a disabled should have the option of being indistinguishable from the rest. This is reminiscent of an avatar Turing test (Turing, 1950) in which, whilst interacting with several able-bodied avatars, one of which is controlled by a disabled user, the test subject is unable to detect any difficulty that a user may have in computer control caused by a disability.

2.2 The Control Demands of a Virtual World

As virtual environments strive for more realism, the barrier of being able to control the appearance of online presence is becoming more critical for disabled users. The move to realism and feature-rich interaction can be seen if we examine four different 'chat' methods; *email*, *chat rooms*, *simple avatars* and *realistic avatars*. At the very basic level of *email* there is no time pressure that the user is faced with – they can take several hours, days or even weeks to respond. A *chat room* requires faster interaction from the user than is required for *email* but it is acceptable to have a few minutes in between responses. Second Life comes under the *simple avatar* category and requires real-time interaction in order to preserve privacy. Many users expect almost instant responses when chatting at this level and not to meet this demand can result in users becoming bored and questioning why the avatar is not responding like everyone else. Online virtual environments have already begun to move towards creating *realistic avatars*. In this category, avatars are able to verbally communicate using VoIP (Voice Over IP) technology. There are also possibilities for the avatar to respond to our facial expressions and body movements due to advancements in facial and gesture tracking. This hierarchy of an ever increasing communication burden on disabled users threatens their choice of disability privacy. Figure 2, highlights the increased difficulty as the demands of communication time (the latency of your response to a communication or action from another online person) and the amount of data that needs to be generated to enable complete communication or control over your online presence increases. It is this ever increasing control bandwidth that is giving rise to avatar realism that contributes to the increasing need for communication and control efficiency. Communication difficulties are further compounded due to the interfaces used in online virtual environment and the fact that they are not designed to aid disabled users.

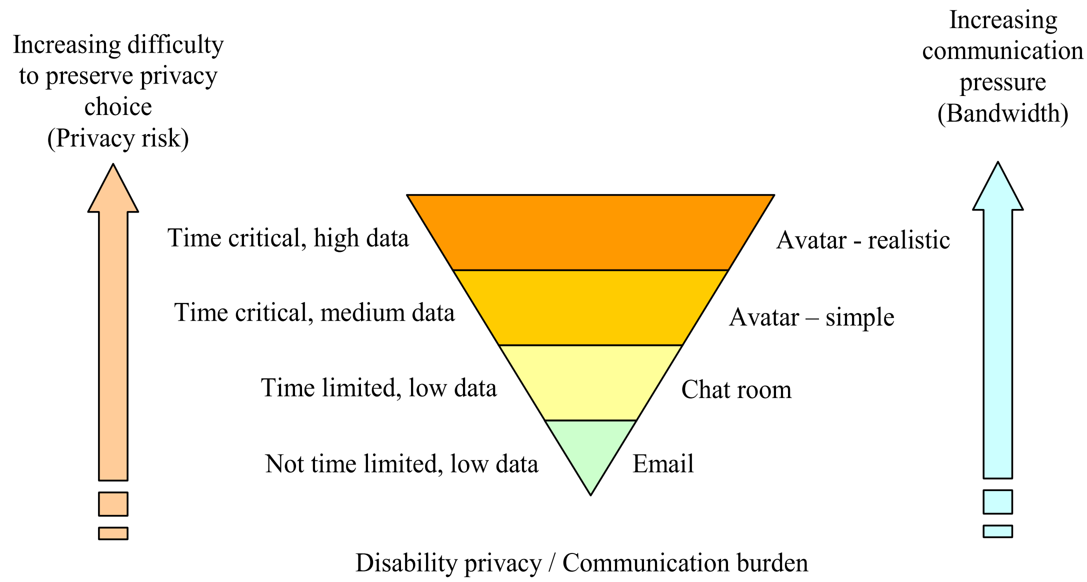

Figure 2. *Disability privacy burden by online meeting type (Bates et al, 2008).*

3. INTERACTION IN SECOND LIFE

To survey interaction and the burden of control in Second Life it was necessary to determine the main type of tasks that occur. Hand (Hand, 1997) previously proposed a taxonomy of main control and manipulation areas that are present in virtual environments: locomotion and camera movement; object manipulation; application control; communication (previously not specified by Hand):

- Locomotion and camera movement. These both may be controlled by using arrow buttons located on semi-transparent overlays as can be seen at the bottom of figure 1. Continuous motion is performed by holding the mouse button and performing a ‘dragging’ motion. There are also keyboard shortcuts to perform avatar movement by using the cursor arrow keys. In many online virtual environments there are also possibilities to use the ‘W, A, S and D’ keys to perform movements.
- Object manipulation. This is only achievable through mouse control. In order to manipulate an existing object then it is selected with a right mouse click, at which point a semi-transparent pie menu appears at the point of click, see bottom right of figure 1. The pie menu offers several options related to the object such as ‘Open’, ‘Edit’ and ‘Sit Here’. A new object is created by selecting the ‘Create’ option within the pie-menu. This causes a dialog box to appear offering basic functions similar to those found in 3D modelling packages.
- Application control. This is mostly accomplished using the mouse although there are several commands and menus accessible via the keyboard. Menus must be opened using left button mouse clicks and although some commands can be accessed using a keyboard the majority of the menu functions are available using mouse only. One of the major functions within Second Life is the changing of the avatars appearance and is only accessible through using a mouse, apart from keyboard tabbing between buttons and using arrow keys with slider controls.
- Communication – chatting and generating text (previously not specified by Hand). This is achieved through text generation or speech relay via a microphone. A chat box lies at the bottom left of the

screen, see figure 1, and text generated through conversation is displayed. Speech relay allows the voice of the user to be heard by nearby avatars, together with hearing any nearby avatars.

These control requirements can be summarised by control source and task domain, see table 1, and allows us to determine what control combinations are required to interact within Second Life.

Table 1. *Control requirements for task domains (Bates et al, 2008).*

	Control source		
Task domain	Mouse	Keyboard	Speech
Locomotion and camera movement	✓	✓	×
Object manipulation	✓	×	×
Application control	✓	Partial	×
Communication	×	✓	✓

3.1 Gaze Control

Users with severe motor disabilities cannot always operate a standard hand mouse or keyboard; and may have difficulties moving their head; they may have some speech but there may be problems with speech recognition die to aided respiration. In most cases however, these users would still retain eye movement since eye control is retained in all but the most advanced cases of paralysis, such as ALS (Amyotrophic Lateral Sclerosis).

Gaze tracking has been show as an effective means of computer control for users with high levels of paralysis (Bates, 2002; Bates and Istance, 2002; Bates and Istance, 2004) and has been used effectively for gaming (Smith and Graham, 2006; Isokoski, 2006; Dorr et al, 2007) and in immersive environments (Tanriverdi and Jacob, 2000; Cournia et al, 2003). One approach to using eye gaze is with mouse emulation by gaze tracking, where the system cursor follows the users point-of-gaze on the screen, and keyboard emulation via an on-screen keyboard. However, simply using the eye as a mouse has a number of problems (Vickers et al, 2008).

It is important to make an initial assessment of gaze based mouse emulation as a satisfactory solution for disabled users interacting with Second Life or similar environments. The assessment would determine if this alternative means of interaction would enable successful, rapid, effective and hence efficient interaction with Second Life by giving users full control over their avatar, whilst not revealing their disability.

4. AN EXPERIMENT

In this initial assessment two expert users of eye tracking and Second Life were chosen to attempt gaze control with the online environment. The issue was not to conduct an in depth study but to simply assess the feasibility of using eye gaze. As a baseline, the participants also interacted with the environment using a normal desktop mouse. Five tasks were constructed from the essential task domains as discussed previously, table 1, of which the avatar was required to perform a short set of actions. The participants were sat approximately 60cm from a 17″ monitor, with the SMI REDII remote infrared eye tracker giving an approximate accuracy of +/- 0,5 to 1cm in cursor position on the screen. The tasks were as follows:

- Locomotion – the participant was required to walk the avatar along a path approximately 2 paces wide around a park, negotiating past trees and other distracting obstacles;
- Camera Movement – the participant was to move the camera from behind the avatar to face it, and then move overhead to view the avatar from above
- Object manipulation – the participant was to create a cube and resize to be as close to 2m cube as possible
- Application control – the participant was to change the appearance of the avatar by making the hair colour blonde
- Communication – the participant was to chat with another avatar, generating the following “The weather here is nice, it is always sunny and warm”.

Completion times together with the errors occurring during the task were recorded, and the subjects were asked to make comments on gaze controlled task areas they found easy or difficult. The average results can be seen in table 2.

Table 2. *Task times and error counts based on task domain*

Task domain	Control source; task time (s); error count Mouse (baseline)	Gaze
Locomotion	48s (3 errors)	88s (4 errors)
Camera movement	50s	122s (10 errors)
Object manipulation	35s	71s (3 errors)
Application control	20s	194s (4 errors)
Communication	60s (11 wpm)	224s (8 errors, 3 wpm)

Four main types of difficulties were identified and were defined as follows:

- Path deviation – movement or wandering from the chosen or desired path made by poor positional control of the avatar direction;
- Distraction – errors particular to gaze control where the gaze is distracted to another object in the world and since gaze is controlling motion direction; that motion is also pulled toward the distraction;
- Accuracy – simple pointing accuracy problems due to the inaccuracy of gaze tracking and pointing resulting in difficulties placing the cursor on small controls;
- Feedback – the continued gazing between the interaction point where gaze is manipulating a control, and the location of the actions or feedback caused by manipulating that control.

We can now discuss the results and examine the effectiveness of gaze control against the baseline of the hand mouse for each of the task domains.

4.1 Locomotion

The major issue was of distraction, where the gaze of the user was pulled away, even temporarily, from the desired destination to some other in-world object, hence moving the avatar toward that object involuntarily. This is illustrated in a sequence (figure 3, left to right) where the gaze (shown as a red star) is distracted by a tree, resulting in the avatar walking into the tree instead of staying on the path.

Figure 3. *Locomotion and distraction.*

Examining the comments made by the evaluators, gaze driven locomotion was regarded as viable: "Steering by eye worked well, all I needed to do was to look at the object I wished to walk towards", "I feel that this could be a very rapid means of steering, just look and you go right there, it could be better than a mouse". However, the main issue of distraction was noted "You can't look around while you are walking without walking off the path".

4.2 Camera Movement

There were a large number of feedback errors caused by the difference in screen location between the camera control and the view of the avatar on the screen. This is illustrated in a sequence (figure 4, left to right) with continual gazes back and forth between the camera control and the avatar (to determine the new camera

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position) resulting in the camera tracking and responding to the movement of the cursor – note how the camera orientation rapidly moves between the user looking at the control (left and right images), and the user looking at the avatar (centre image).

Figure 4. *Camera movement and feedback.*

4.3 Object Manipulation

Of particular interest was when once the handles of the object were acquired, the object could be resized very effectively with gaze due to the appearance of rulers extending from the object, with the user simply needing to gaze at the required measurement (placing the cursor on that measurement) for the object to be correctly resized. This is shown where the user is gazing at 4m on the ruler thus resizing the object to 4m (Figure 5).

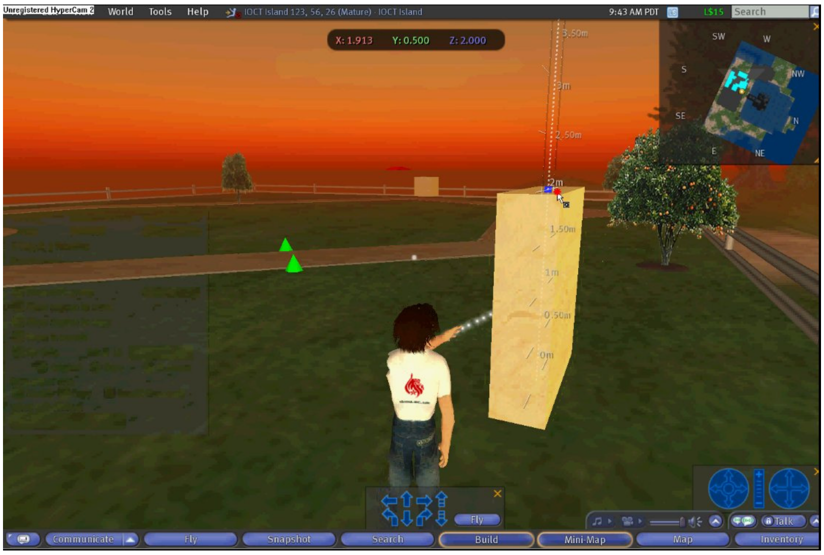

Figure 5. *Object sizing by gaze.*

4.4 Communication

The use of an on-screen virtual keyboard was slow for the mouse (11 words per minute) and very slow for gaze (3 words per minute), thus presenting a significant communication problem for our disabled user. This is illustrated by red lines (gaze paths) and red dots (gaze fixations) showing the many gazes between keyboard and chat box on Second Life when writing only 10 characters (figure 6).

Figure 6. *Feedback while gaze typing.*

5. CONCLUSIONS

The ideas, concepts and data presented in this paper form the basis for preliminary observations and are intended to indicate directions for research rather than to provide definitive answers. It is shown from the results and difficulties found that using eye gaze is constrained by the existing interfaces and will not deliver the bandwidth of interaction necessary to safeguard the privacy choices of disabled users. At present existing virtual world interfaces will almost always force the disabled user to not perform as well as more able users, and hence fail the avatar Turing test.

The types of difficulties found suggest a need for a lightweight ‘gesture’ mechanism (Istance et al, 2008; Vickers et al, 2008) whereby gaze control can be activated and deactivated quickly and effortlessly, with direct gaze manipulation of locomotion and objects within the virtual world. This is illustrated by object manipulation, where the experiment showed that objects were very effectively manipulated by gaze. A control action can be applied by eye and then gaze control is deactivated to enable the user to see the effect of the action and to look at the objects nearby. Gaze-based gestures may be a potentially fast way of achieving this, and are quite analogous to the real world – for example, if we wish to walk toward the door we first look at it, look at the path between ourselves and the door, and then move toward it – surely this should be the same in virtual worlds? Then with more accessible (and probably more immersive) interfaces the users' avatar gaze direction would indicate the direction to walk with no further control required – preliminary work on this has already suggested that gaze may be more efficient than the standard method of desktop mouse for locomotion control – as we look and gaze where we wish to go. It is now time for the providers of virtual worlds to add these accessibility functionalities to their worlds.

Using gaze to interact with virtual environments as a modality for disabled users is still at an early stage of investigation but it already holds much promise for a method of liberating these users into a Second Life where they may choose to be disabled or not. The challenges of using gaze alone to interact in real-time (or close to real-time) with virtual environments are considerable, but if these can be met by more accessible (and helpful) interface design then there will be greater opportunities for disabled users to participate fully in virtual communities; but until this control is fully realised then disabled users may feel that they have challenges to their choice of on-line privacy.

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