Utilizing Virtual Worlds for Personalized Search: Developing the PAsSIVE Framework

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Abstract. Search engine technology has greatly enhanced our ability to filter through the chaos of finding relevant information online. Despite the current capabilities, however, there is the promise of further improvement through the use of personalization and alternative interfaces. In this paper we examine one such alternative named PAsSIVE (Personalized Assisted Search in a Virtual Environment). PAsSIVE immerses the user in the virtual world of Second Life in which results are rendered. As part of this research, we investigate the design and development of a 3D search interface, and reflect on insights gained. This paper also discusses future work related to personalization and proactive search.

Keywords: Virtual worlds · Personalized search · Second life · PAsSIVE

1 Introduction

There have been a growing number of 3D environments that have emerged for a vast array of purposes and target age groups [14]. With a wide range of multi-user virtual environments (MUVEs) available today, social interactions and applications of all kinds are increasingly common place. Adding to these forms of interaction, there is the possibility of extensions and integration into other applications through scripting languages, allowing for additional features. From this added flexibility, some virtual worlds allow for the possibility of interacting with web data in a more realistic and natural way. Despite the diverse virtual worlds and features available, they all have some common characteristics, particularly with the user's representation, the avatar. An avatar is a personification of the user as an interactive artifact, with a level of habitation (which enhances realism of the space) and a representation or sense of space [17]. MUVEs can be used in a range of domains, including education, simulation, data visualization, business, and much more, with far reaching implications [1, 24, 25].

Due to its popularity, flexibility and applicability for research, Second Life was chosen as the virtual world to utilize for this project. Second Life is an Internet based three-dimensional virtual world, created by Linden Labs. Other similar virtual environments include Twinity, Active Worlds and There. Linden Lab encourages creativity among its user base, and allows for the protection of Intellectual Property of created

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elements in-world. Users interact within Second Life with objects and other users. One can customize the appearance of their avatar, transform their environment (by creating virtual objects), communicate, collaborate and cooperate [11]. The "residents" of Second Life create content and communicate via text chat or voice communication. Interactive objects are built by using a scripting language (Linden Script Language) that is designed to theoretically be simple enough for those with little previous programming experience.

In this project, the aim is to use the inherent visual display and immersive qualities of Second Life for the main interface of a search engine, while alsoimproving the results through personalization. Many researchers agree that in order for search engines to effectively personalize results, they must tailor their actions based on information from individual users and web content [10]. It follows, therefore, that search engines should incorporate (a) the individual user's general interests, (b) the individual user's current information need, and (c) information about the content searched. The search agent PAsSIVE (Personalized Assisted Search in a Virtual Environment) is designed to use a virtual world interface while incorporating these three points towards personalization. Another unique aspect of the personalized search agent is the ability to perform self-directed, proactive search of web content while the user is offline. This feature adds new content to the search index, which is more specific to the user's general interests, building a more custom tailored set of links. As the system learns more about the user, search results are ranked using amulti-layered approach making use of both content, page structure and user interests.

To address the problem of users needing to sift through the many links of a search query, the PAsSIVE system search results are presented as a 3D visualization within Second Life. The user's avatar is used to both perform a search and navigate through the search results. The goal of the visualization is to present the resulting information in a more intuitive form than simply as a list of links. The goal of this work is to demonstrate the potential for personalized, proactive search in a 3D environment. The overall long term research questions for this project are: (1). What demonstrated potential is gained through this type of search framework? and (2). Is there demonstrated potential in satisfying a user's information need by the use of a 3D visualization of search results? In this paper, we reflect on feedback gained from the design of the interface as we seek to investigate our overall research questions expanding on our previous research [3].

2 Virtual Environments as a Search Interface

Over the past several years there have been a growing number of data, text and web mining tools that utilize traditional statistical analyses to find trends. Many of these tools differentiate themselves through various visualization techniques [26]. This same trend can also be seen with mainstream search engines, as the search interface visualization is how people interact with the system and is how links are displayed, serving an important role [12, 16]. As virtual worlds like Second Life have potential beyond their intended scope, we foresee many new creative and innovative developments from these technologies in the future, specifically regarding visualization.

The role of the interface for a virtual environment is to provide a graphical representation of the environment in which the user is interacting. In our case we are extending the interface to mean, not simply the environment "window" itself, but the graphical representation of our 3D search interface and its display of search results. PAsSIVE uses the virtual world to show the search results in an immersive way while being an interactive component of the user's avatar. This idea allows for interactions that limit the breaking of the "Magic Circle" while also potentially maintaining immersion by allowing all interactions for search to happen in-world. Many Projects have used 3D environments for visual displays and Information Retrieval purposes. These projects have used 3D spaces in a limited way to project a representation of images or results to help the user view content [6, 19]. These experimental systems have included the display of shapes or colors to display document similarity or explored content, or by using spatial metaphors to assist with navigation [13]. There have been other initiatives aimed at visualizing web content by displaying traditional 2D lists into a 3D space [18] or by using other variations on treemaps [8]. Others aimed at creating virtual objects such as virtual interactive "books" that mimic a physical book where one can flip through "pages" of similar content [5]. In contrast, implementations using technologies such as VRML for 3D interface applications for use on the web has generally not caught on.

Several major industries have gained substantial benefits from using 3D representations such as in medical imagery, architecture, and computer aided design [20]. Advancements in display technology, including the Oculus Rift, have afforded new possibilities for visualizations [15]. As cited by Rohrer [18], there are several common approaches for visualizing hierarchal data: cone trees, treemaps and hyperbolic browsers. Objects that represent information can be displayed in a way to emphasize certain data by changing size, height or surface appearance [7]. Additionally, the VR-Net project of Cleary et al. [9] used a VRML based interface to visualize related search results in a virtual space. Pages are represented as basic objects (box, cone, cylinder, line and spheres) and displayed based on reaction to the query and other topics related to the topic.

There have been several attempts to visualize large quantities of information by researchers in the domain of information visualization. However, very limited research has been conducted using virtual worlds or online games for visualization. One example of an integrated application is the Sloodle browser, an open source Second Life tool in which avatars can collaboratively interact to view web content often associated with the Moodle Learning Management System [22]. Another example is Daden Limited's DataGlobe, a 3D interactive globe created for Second Life that can be clicked on specific areas to view information about an item or information on a nearby display screen [2]. DataGlobe was made interactive via LSL and linked data feeds and other outside information from the web. In a separate project by Daden, live air traffic data can be visualized in Second Life. Smallman et al. [23] have a similar display using a traditional 3D display of aircraft data. Virtual worlds in particular are very flexible simulations that can incorporate degrees of real and unreal elements. Due to the potential of interactivity, flexibility and the benefits of 3D search interfaces, coupled with the rise of popularity of virtual worlds, we have chosen to design PAsSIVE's interface as a virtual browsing object or component as described in the next section.

2.1 The Virtual Browsing Component (VBC)

Unique to the design of PAsSIVE is its interface. To our knowledge, no other personalized search engine currently uses an online game or virtual world as its primary interface. Since PAsSIVE is integrated into Second Life, users need a representation (avatar) in the environment. The user controls their avatar to interact within the world of Second Life, and specifically with the Virtual Browsing Component (VBC). It is through the avatar that the user is able to search and view results. The location of the virtual browsing component is at a fixed point within Second Life and requires approximately 1024 meters of simulated land.

To use the PAsSIVE system, one's avatar would walk within ten meters of the VBC and click the search object to activate it. This object looks like a magnifying glass. The user can then "speak" (via the default text chat channel #10) the search query they which to submit to the system. The query is then intercepted and tokenized by a script written in the Linden Scripting Language (LSL), and then passed to a PHP script running on a webserver that is listening for search requests. LSL is required in order to make objects in Second Life interactive or to connect to external programs outside of Second Life. LSL "follows the familiar syntax of a C/Java style language, with an implicit state machine for every script" [4]. The framework for PAsSIVE is implemented in the Python programming language, but connects to Second Life using LSL via the HTTP request library. Data from any user interaction including query terms are sent to the agent, processed, and then sent back to SL. Based on the search query, the Search Personalization Component (SPC) sends back to the VBC the top 10 URLs that it has calculated to be the best match to satisfy the user's information need. Each of the 10 URL's returned are sent to individual display units that display a given URL and various personalization values as part of the interface.

A key benefit of using a 3D virtual environment is having the ability to manipulate multiple camera views and the avatar's positioning, and the ability to change virtual objects. Users of virtual worlds have certain expectations of interaction. As with most displays of information "Users will want to filter, select and restructure their information rapidly and with minimum effort" [21]. The display of search results follows this idea, with the presentation of personalized links in a simple, filtered approach that can be viewed in different ways and angles. Once a data sphere receives the URL data it represents, it changes its color and position (and sometimes movement) to indicate to the user the strength of likelihood that it matches their search interests. Above each sphere, the webpage appears for its respective URL. If the user clicks on a sphere, the actual webpage is loaded into the main display area, where the user can use and interact with the site as normal. When a user clicks on a website, that information is sent back to the SPC.

3 Preliminary Survey Discussion

A preliminary survey was conducted to gain insight into three main aspects of user interactions with search engines. This included collecting information on 1. Typical user search habits and encountered problems; 2. Participant willingness to interact

within a 3D search engine environment compared to a traditional web based applications; and 3. Preferences for using personalization features. In the paper, we are only reporting the main findings related to the interface.

The survey was administered to two classes at Towson University (the second author's institution) in the fall of 2011 and 2012. Both classes consisted of 30 Information Technology students (for a total of 60 students for both semesters) in a class titled "Emerging Internet Technologies". This is an elective course for junior and senior IT majors. Due to the specific course content, all students surveyed had previously used search engines and were also familiar with the concept of search personalization, the basics of search engine functionality, and the use of virtual worlds (specifically Second Life). From both classes, fifty-seven participants responded for a 95.0 % completion rate. The average age of the participants was 23.9 years old and consisted of forty-five males and twelve females. The feedback obtained from the preliminary survey was advantageous in gaining better insight into the general problems, interactions and desired features of search engines from advanced users.

We were also able to gain some insights for the design on the 3D PAsSIVE interface survey. In general, from the participants surveyed, we were able to substantiate that search engines are used frequently, and that despite their usefulness, there is still considerable room for improvement to meet the needs for users. Fifty-six percent of the participants surveyed noted that they do use additional features (Advanced Search) offered by search engines to enhance their searches. Many also noted that their primary search engine still provides irrelevant search results despite the fact that they felt they were provided mostly good search results. Often there was still a need to update their query or evaluate additional links in order to satisfy their information need. Regarding the display of search results returned to the users, most (71.9 %) reported that they did not feel there was a need for any visual changes to the interface. Only a small number believed that changing the display of the results would have a beneficial effect on search engine usability (17.5 %). From the summary of responses from the proposed interface changes, there was a wide variety of comments without a consensus on any particular change. However, sixteen participants from those suggesting general improvements (28.0 %) did note that providing better or more refined search results would be useful. Regarding personalization specifically, the majority of the survey participants (65.0 %) responded "yes" or "maybe" regarding their willingness to use of a more personalized search engine, but some expressed concerns about privacy and the potential for more biased results.

The final part of the survey focused on gaining feedback regarding their potential use of a 3D search engine. When the students were asked if they would use such a system if one were available, the results were generally mixed. Thirty-five percent noted that they would not use such a program, 40.4 % of the participants said "Yes", and 24.5 % said "Maybe". In this particular study, the participants were not provided a particular visual representation of a prototype for that question. Comments, however, about the possibility of a 3D search engine revealed that such a program could be useful and potentially allow for quicker reading of results, while also potentially more distracting and harder to use.

Lastly, the participants were shown three images of a 3D display of a search interface. These were based on a general Tree Structure, a Search "Room", and also a

set of linking virtual spheres in Second Life. When asked which potential display they would prefer as a 3D search engine interface, the results were mixed. It is important to note that with this question there was no discussion on how these prototype designs would specifically function; users were simply provided the image. An equal number of the participants (21) reported that they preferred the Tree structure and Link sphere design, while the remaining 14 participants preferred the idea of a "Search room". From this question we wanted to investigate if the participants had a particular preference for one design over another. Since the majority of users noted the first and last design, we improved the PAsSIVE interface to include a better display of the results and changed how the results were displayed. With a tree based structure, the hierarchical nature of the result placement can provide insightful meaning of relationships. Using this idea, combined with the original idea of the link sphere structure, the PAsSive interface was updated to provide a combination of these features.

4 Interface Survey

A second survey designed to gain insights into the construction of the interface of PAsSIVE was administered in the fall of 2013 in a course at Towson University titled: "Virtual Worlds: Impacts of Online Interaction". The participants for this survey were all very knowledgeable of Second Life, and had experience scripting and using advanced features and controls. All participants also had experience using interactive objects in-world and had spent at least one full semester using SL. Additionally, all participants were experienced search engine users. For this survey there were a total of 21 participants, with all 21 responding to the survey, yielding a 100 % response rate. The survey was administered electronically.

The survey consisted of two open-ended questions. The first question asked participants to imagine the idea of using a virtual world to search and view information online in a 3D space through an avatar, and "If a 3D search engine existed in Second Life, how would you imagine the information would appear or be displayed"? Table 1 summarizes the main points outlined by the participants, including response frequency.

Table 1. Summary of proposed display interface interaction

Main feature	Frequency (n = 21)
Floating screen, webpage or holographic display	7
Information displayed around user or in environments	5
User can choose view or display type	5
Displayed as a normal webpage	4
Search room or space	3
Virtual computer or object to be used by the avatar	3
Virtual objects are associated with the search	2
Includes voice or other sound	1
Clickable objects that display page	1
Heads-up Display (HUD)	1

While most responses for this question varied in detail and length, the "main feature" description was used to delineate the response in constructing the table below. Participants could list multiple features in their responses.

The second question described a particular scenario, and also included an image of a preliminary design of PAsSIVE and asked participants to comment. The following statements were provided:

> *How would you feel about a 3D search engine interface as provided in the image? In this example, websites are displayed based on what an avatar is searching for. The top search results are displayed as web pages around the user. If the user likes a page, and wants more information about it, they are able to click on the colored sphere where the page would load in the web browser. Please explain how you feel about the display in detail.*

The purpose of this open-ended question was to gain additional feedback on the PAsSIVE interface as a result of the adjustments from the first survey administered. The image and scenario presented to the participants was based on the actual implementation of the program. The responses to this question was greatly varied and difficult to summarize. However, several general themes emerged. Twenty participants (95.2 %) expressed a positive sentiment towards the presented design. (One participant felt that the information presented was forcing 2D content into a 3D space, and preferred to use a regular browser.) Four participants (19 %) commented on the colored spheres, noting that they were either too big, unnecessary, or out of place. Generally, the comments did not indicate the need for major changes. Several comments pointed out such things as the potential need to change camera angles, and moving the avatar to view information more clearly (or zoom into the web page display area).

5 Discussion

Many of the results of the first survey did correlate with our expectations and the findings in the literature about search and search interface problems. The interface survey in particular was essential as we are making changes to the program and updating the design before carrying out more experiments and in-depth user testing. As the participants of the second survey were very familiar with Second Life, we were able to better understand how potential users of the system would view such an application. As a result of this information, the following changes are being implemented to improve the design:

- Shrinking the overall area of the interface to a more manageable size.
- Making the size and location of the colored spheres less obtrusive.
- Providing more feedback through the sphere about web pages in relation to a user's query.
- Including a link to a video tutorial and detailed instructions in text on how to use the system (which can be accessible in-world).
- Changing the display of the web pages for easier viewing.

Feedback obtained from both surveys was helpful making improvements and justifying some features. We plan on conducting other surveys and testing which is discussed in the next section.

6 Conclusions and Future Work

This paper discusses some of the key ideas and results of the development of the PAsSIVE agent framework, in particular the interface. The framework provides personalized search using Second Life to render search results. Through one's avatar, the user is able to view web content, and search and manipulate results. As the project investigates the use of both personalization and user interaction within a 3D interface, this paper mainly focuses on the interface design. The survey results were very useful for the continued development and testing of the system. The resulting changes to the overall size, color and the angle of the in-world object, we believe will improve navigation. Eventually, we want to take advantage of the full range of motion and camera angle capabilities to truly make an immersive search object that is more integrated and natural than current 2D renderings. Although the first survey was limited and a pilot for later designs, common search problems and desired search features were identified. The second interface-focused survey was helpful in finding features expected of a 3D search interface, and reactions to the latest 3D design. In the near future we will be updating the overall design of the virtual interface, and implementing some of the changes needed for further personalization. Through this research, we aim to eventually demonstrate the effectiveness of search interfaces that incorporate the features of 3D visualization, personalization, and proactive search.

References

1. Balkin, J., Noveck, B.: The State of Play: Law, Games, and Virtual Worlds. University Press, New York (2006)
2. Boulos, M., Burden, D.: Web GIS in practice V: 3-D interactive and real-time mapping in Second Life. Int. J. Health Geogr. **6**(51), 1–16 (2007)
3. Braman, J., Dierbach, C.: Using Second Life as an interface for personalized search. In: Proceedings of SLACTIONS Research Conference in the Second Life World (2010). http://slactions.org
4. Brashears, A., Meadows, A., Ondrejka, C., Soo, D.: Linden Scripting Language Guide. Linden Lab, San Francisco (2003)
5. Card, S.K., Robertson, G.G., York, W.: The web book and the web forager: an information workspace for the world-wide web. In: Proceedings of the SIGCHI conference on Human factors in computing systems, pp. 111-ff. ACM (1996)
6. Christmann, O., Carbonell, N., Richir, S.: Visual search in dynamic 3D visualizations of unstructured picture collections. Interact. Comput. **22**(5), 399–416 (2010)
7. Chuah, M., Roth, S., Mattis, J., Kolojejchick, J.: SDM: malleable information graphics. In: Proceedings on Information Visualization (INFOVIS 1995), pp 36–42. IEEE Computer Science press, Los Alamitos (1995)

8. Clarkson, E., Desai, K., Foley, J.D.: Resultmaps: visualization for search interfaces. IEEE Trans. Visual Comput. Graphics **15**(6), 1057–1064 (2009)
9. Cleary, D., O'Donoghue, D.: Creating a semantic-wed interface with virtual reality. In: Proceedings of the SPIE – The International Society for Optical Engineering, vol. 4528 pp. 138–146 (2001)
10. Eirinaki, M., Vazirgiannis, M.: Web mining for web personalization. ACM Trans. Internet Technol. **3**(1), 1–27 (2003)
11. Fetscherin, M., Lattemann, C.: User acceptance of virtual worlds. J. Electron. Commer. Res. **9**(3), 231–242 (2008)
12. Hearst, M.: Search User Interfaces. Cambridge University Press, Cambridge (2009)
13. Hemmje, M.: Lyberworld: a 3D graphical user interface for fulltext retrieval. In: Proceedings of the ACM SIGCHI 1995, pp. 417–418 (1995)
14. KZero.: KZero Reports – Universe Charts (2014). http://www.kzero.co.uk/
15. Oculus VR.: Oculus Rift (2015). https://www.oculus.com/rift/
16. Morville, P., Callender, J.: Search Patterns. O'Reilly Media, Inc., Sebastopol (2010)
17. Pearce, C.: Communities of Play: Emergent Cultures in Multiplayer Games and Virtual Worlds. MIT Press, Cambridge (2009). ISBN 978-0-262-16257-9
18. Rohrer, R., Swing, E.: Web-based information visualization. Proc. IEEE Comput. Graph. Appl. **17**(4), 52–59 (1997)
19. Schoeffmann, K., Ahlstrom, D.: Using a 3D cylindrical interface for image browsing to improve visual search performance. In: IEEE 2012 13th International Workshop on Image Analysis for Multimedia Interactive Services (WIAMIS) (2012)
20. Shneiderman, B.: Why not make interfaces better than 3D reality. IEEE Computer Society **23**(6), 12–15 (2003)
21. Shneiderman, B., Plaisant, C.: Designing the User Interface: Strategies for Effective Human-Computer Interaction, 4th edn. Addison Wesely, Boston (2005). University of Maryland, College Park
22. Sloodle: Sloodle Browser (2010). http://www.sloodle.org/browser
23. Smallman, H., St. John, M., Oonk, H.: Information availability in 2D and 3D displays. IEEE Comput. Graphics Appl. **21**(5), 51–57 (2001)
24. Vincenti, G., Braman, J.: Teaching through Multi-User Virtual Environments: Applying Dynamic Elements to the Modern Classroom. Information Science Reference, Hershey (2010)
25. Vincenti, G., Braman, J.: Multi-User Virtual Environments for the Classroom: Practical Approaches to Teaching in Virtual Worlds. Information Science Reference, Hershey (2011)
26. Yang, Y., Akers, L., Klose, T., Yang, C.: Text mining and visualization tools- impressions of emerging capabilities. World Patent Inf. **30**(4), 280–293 (2008)