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A Framework for Design and Evaluation of Digital Museums in Second Life as Learning Institutions

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***Abstract*—Over two decades, a great expectation on digital museums has been addressed, but most implementation platform has been web technologies. Emerging Second Life which supports rich communication, virtual collaboration, and 3-D content creation has carried out a new platform of digital museums. This paper investigates the requirement of idealized digital museums to improve the percentage of returning visitors and to impress the first-time visitors. The framework for design and evaluation of digital museums in Second Life as learning institutions is elaborated and discussed in the paper.**

I. Introduction

Several museum studies in the 3D virtual world have been designed, developed and evaluated since Linden Lab launched Second Life (SL) in 2003 accessible via the Internet. Immersively interactive feature embedded in SL has attracted the attention of up to 30 organizations existing in Real Life (RL). For example, the Smithsonian Latino Center opened the Smithsonian Latino Virtual Museum (LVM) in March 19, 2009 which provides the vast and rich collections, research and scholarship, exhibitions and educational activities of the Smithsonian Institution as they relate to U.S. Latinos and Latin America. To design and develop digital museums in SL, the new frontier in education has been considerably evaluated in recent years.

Nowadays, emerging a hundred of web-based museums has been proposed to improve preservation and access through digital technologies. For example, a digital museum of Taiwanese butterflies [1], Tokyo digital museum published via *http://digitalmuseum.rekibun.or.jp* as well as Okayama digital museum accessed via *http://www.okayama-digital-museum.jp*. Four discussion topics on the digital museum impact are shown in [2], [3]:

- Management operation with reliability and availability
- Availability for anyone who can access through the Internet
- Convenience for users who are willing to be collaborative
- Reduction of housing and exhibiting artifacts

With a great number of attempts to find the convergence of the new and the old and dusty, there are four obviously positive changes but some misgivings. For example, web users cannot experience museum-like environment such as strolling and talking with people who have the same interests in an art gallery.

Learning is one of the motivations of museum audiences as discussed by Russo and Peacock [4]. To support the friendly and informative learning environment, the proposed framework of digital museums in SL is partitioned into three main modules: visiting, interacting, and participating. First, the visiting module is directly responsible for the primary role of museums to exhibit the tangible and intangible heritage of humanity. Second, the interacting module organizes the learning activities based on a huge of researches in human computer interaction field better than those based on the sliding presentation in the classical learning. Lastly, the participating module arranges the collaborative research environment to support whoever, i.e. curators, designers, owners, researches, are willing to design, develop and evaluate the exhibitions, events, seminars, and so on.

The main issue of learning-based digital museums is how to explore information seeking visitors' behaviors in a digital museum [5]–[8]. Several researches of which experiments were conducted in RL proposed the categorization of user types based on behavioral traits [9], [10]. There are three main categories as the followings:

- Greedy visitors who want to know and see as much as possible
- Selective visitors who spend time on artifacts that represent certain concepts only and neglect the others
- Busy visitors who prefer strolling through the museum in order to get a general idea of the exhibition without spending much time on any exhibits

Among a number of exhibits and events in digital museums, the selective exhibits of the individual preference can be guided by the museum. A personal tour route with description corresponding to the visitor type can maximize his/her satisfaction.

The rest of the paper is organized into two sections. Section 2 describes a framework of design and evaluation of digital museums as learning institutions. To design and evaluate museums as learning institutions requires an investigation of visitors' types, in which data mining approaches are applied. Section 3 summarizes the paper.

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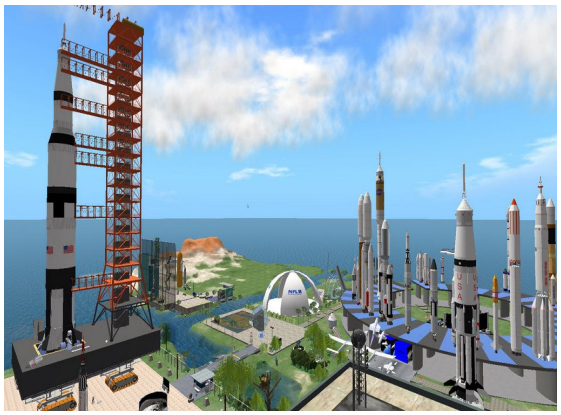

Fig. 1. International Space Flight Museum in the Exploratorium

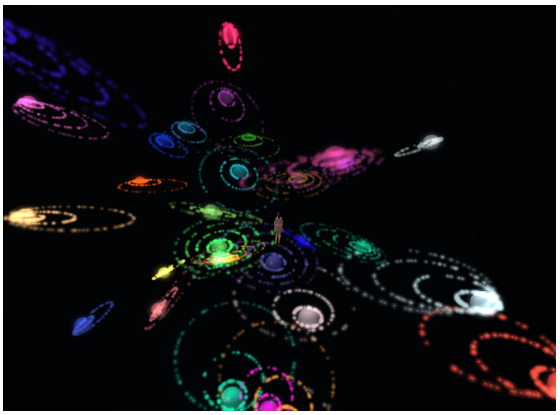

Fig. 2. Big bang simulation in the Exploratorium

II. Digital Museums in Second Life

With a population in the millions and a monthly growth rate of more than 20 percent, SL is a virtual 3-D world bursting with opportunities in areas like collaborative learning, legal practice, corporate connections, and people [11]–[15]. Virtual World, also known as Synthetic World, is a computer-simulated persistent environment similar to RL. Users in SL are called residents which are represented by avatars. Like most of other virtual worlds, SL can support massively multi-player to be on-line at the same time. Over 50,000 avatars were on-line simultaneously in SL as reported by Reuters [16] since September 2008. SL provides a wide spectrum of on-line activities, including arts, science, sports, and education. Within it, the residents can explore, meet other residents, socialize, and participate in all kinds of activities [11]–[15].

The challenges for the traditional museum model of working with virtual environments are presented in SL. Museums in SL vary tremendously in terms of size and scale, ranging from single installation to extended complexes where exhibits are arranged over an entire island. Unlike RL, museums in SL can display artifacts that maximize vertical space as well as horizontal. It is possible to show artifacts in the open air or even have them floating in mid-air without any worry on theft or deterioration over time. For example, Spoland, associated with The Exploratorium - the museum of science, art and human perception in San Francisco, exhibits spacecrafts in open air as shown in Figure 1 and the big bang simulation expanding universe as shown in Figure 2. Figure 3 shows the traditional display all artifacts on the wall in LVM.

Another challenge is identifying and targeting specific audiences in SL because the nature of interacting with individuals in SL, combined with the typical SL citizen reluctance to give out information about their RL identities, makes it very difficult for museum professionals to administer surveys or conduct needs assessments in SL. Beyond counting the number of visitors who come through the door and encouraging visitors to leave comments in a guest book, there is little at this point that museum professionals can do to learn more about their visitors in SL [17]. For example, EPN shows the number

Fig. 3. Traditional exhibitions

of residents who lied about their real gender is approximately 10 percent.

Therefore, analyzing user types has been required in SL. EPN [18] discovers that the motivation to participate in SL is diverse as the descending order: (1) Fun (2) Doing things that cannot do in RL (3) Making friend (4) Learning and (5) Part-time. Residents' motivation obviously supports that SL museums must encourage visitors to return again and again by analyzing visitors in their personal styles as well as many museums try to do Customer Relationship Management (CRM) in RL. Classification and identification of visitors' activities in SL museums by analyzing log files of their movements are practical.

A. Modularization framework

The target audiences of digital museums can be classified as follows:

1) Visiting audience, approximately 90% of users in SL just stops and looks around the exhibitions.
2) Interacting audience, only 9% of users contributes from time to time.
3) Participating audience, rarely 1% of users participates a lot and account for most contribution.

Therefore, the framework of above classification is divided in three modules , which is based on a '90:9:1 rule' for new social media [4]. Basically, visiting users are defined as the visitors strolling in art museums. Interacting users are defined as the visitors preferable to keep note cards or other objects given in museums. Users spending much time in museums and preferable to attend in many activities such as events, seminars, and workshops are called participating users.

The visitation is also considered in two types as follows:

1) First-time visitation, which are greater than 90% of visitors in RL.
2) Repeating visitation, which are solely happened in RL because of the traveling expense and time.

In the proposed framework, the visitor type's classification is implemented to distinguish the first-time visitation in three categories: crawling, leaping, and swimming by using spatio-temperal data mining technique [19], [20]. The first two modules, visiting and interacting, support the guidance for the first-time visiting audiences. The visiting module generates the appropriate path corresponding to the user type and the interacting module produces the appropriate description to the user type. The third module, participating, supports and encourages the repeating audiences by using Customer Relationship Management (CRM).

B. Visitor type's classification

Umiker and Sebeok [21] compared the visitors movements with the behavior of three movement patterns. They are distinguished into crawling, leaping, and swimming. Crawling is defined as a steady, systematic, movement from beginning to end. Leaping pattern is characterized by a more erratic jumping back and forth between displays in different parts of the gallery. Swimming pattern is described as one where the visitor flows through the center of the gallery space with almost no stops. These distinguished patterns are examined and reported with the following percentages: crawling (46%), leaping (44%), and swimming (10%). The proposed framework in visiting, interacting, and participating modes can support all the user types corresponding to their information seek.

C. Visiting module

The user can spend their valuable time in the museum as following categories:

1) Users in crawling patterns are likely pleased to spend long time in the museum and desire to learn every detail of the exhibits, which are belonging to the greedy visitors.
2) Users in leaping patterns are willing to spend their valuable time in the museum and desire to stopover only selected exhibits, which are belonging to the selective visitors.
3) Users in swimming patterns are so busy that they possibly observe and learn the general information about the exhibits, which are belonging to the busy visitors.

D. Interacting module

A simply interactive function in art galleries is implemented by using note cards, which users choose to keep in their inventory. The interactive multimedia used to describe the artifacts can be implemented by using many SL functions such as video, slide, and sound presentation. The interacting module can guide the users with appropriate presentations based on guide systems [22]. Zancanaro et.al. [23] described the mobile usages in multimedia guidance into four groups as follows:

1) Users almost always interact the guide system from the introduction to the conclusion with longest time.
2) Users almost always avoid the guide system.
3) Users almost always skip the introduction to the conclusion of the guide system.
4) Users almost always start the introduction but not reach the conclusion of the guide system.

In our framework, the first user group possibly corresponds to the greedy visitors that the interacting module will provide the full description of each artifact. The second user group is likely related to the busy visitors that the interacting module is disable. The third and forth user groups are implied as the selective visitors that the interactive module varies considerably in the description length of each artifact.

E. Participating module

Last stage of digital museums is another attempt to provide a tool for users to add their contents. It might convince a potential visitor to become an actual user, which is a member of museum designing and developing team. The participation plays a role of a visitor-centered museum such as discussion rooms and laboratories. This module aims to support the repeating visitors based on their preferences and professionals as described in [24].

Another example is that visitors can perform Okuri in Japanese traditional dance following an instructor. It clarifies the strategy to deliver the knowledge to the visitors as a role of learning center. Participation stage can be sub-modularized into specific activities such as dancing, discussion, and chatting. Discovering information from visitor participation have been investigated by using neural networks [25].

F. Evaluation

The following indexes are proposed to evaluate the framework performance, which are divided in three modules, visiting, interacting and participating.

1) Attraction index indicates the performance of visiting module. Attraction index of a personal route is calculated by the number of exhibits that visitor have stopped over by the total number of exhibits in the route. The indicator provides an initial idea of the power of attraction or attention exerted by the proposed framework. The index varies from 0 to 1, and the closer it is to 1 the greater is the power of the visiting module.
2) Holding power index measures the average time spent in front of an information/communication element (e.g. a

video, a sound, a slide etc.). Given personal presentation with the expectation spent time in the route, the holding power index is calculated by dividing the average spent time of the route by the expectation time of the route. The index ranges from 0 to 1. It may be greater than 1 if the average is greater than the time considered necessary but this is a theoretical case. The closer it is to 1, the greater the ability of the element to hold the visitors attention will be.

3) Repeating index measures the performance of participating module. It is calculated by the number of visitors repeating the museum by the number of first-time visitors. The index varies from 0 to 1, and the closer it is to 1 the greater is the power of the participating module.

Besides the above indexes, there are other parameters involving the museum visitors and exhibitions. For example, utilization times [26] are the average times for the complete visit by user types. The utilization times are used to adjust the expectation time generated by the visiting and interacting modules. Sweep rate index is calculated by dividing the total size of the exhibition in square meters by the average time spent by visitors within this exhibition area. It is used to calculate if visitors move slowly or quickly through the exhibition. It is possible to calibrate comparisons among museums of different sizes.

Diligent visitor index [26] is obtained by calculating the percentage of visitors who have stopped in front of more than half the elements that make up the exhibition, which is corresponding to the percentage of the greedy users. The percentage of diligent visitors helps evaluate to what extent the exhibition has been visited. The index also helps to assess whether or not the ratio of the density of objects to the time available is adequate. A low value might be interpreted as indicating that the exhibition is too long or too dense for the available time or for the attention-span of the average visitor, rather than as indicating a low level of study and interest.

III. Conclusion

This paper carried out a modularization framework of design and evaluation of digital museums in Second Life as learning institutions. The main discussion issue is how to seek information from visitors' behaviors, which are mainly divided in three types of motivations: visiting, interacting, and participating. In the future, the museums must face the high competitions so the prospective museums require an essence of the proposed framework for being a self-learning center, not only reserving and displaying ancient artifacts.

References

[1] J.-S. Hong, H.-Y. Chen, and J. Hsiang, "A digital museum of taiwanese butterflies," in *DL '00: Proceedings of the fifth ACM conference on Digital libraries*. New York, NY, USA: ACM, 2000, pp. 260–261.

[2] H. Brocks, U. Thiel, A. Stein, and A. Dirsch-Weigand, "Customizable retrieval functions based on user tasks in the cultural heritage domain," in *Research and Advanced Technology for Digital Libraries*, ser. Lecture Notes in Computer Science, vol. 2163. Berlin / Heidelberg: Springer, 2001, pp. 37–48.

[3] H. Din and P. Hecht, *The Digital Museum: A Think Guide*. Amer Assn of Museums, 2007.

[4] A. Russo and D. Peacock, "Great expectations: Sustaining participation in social media spaces," in *Museums and the Web 2009*, Mar 2009, pp. 60–69. [Online]. Available: http://www.archimuse.com/mw2009/papers/russo/russo.html

[5] D. Bolchini and P. Paolini, "Goal-oriented requirements specification for digital libraries," in *Research and Advanced Technology for Digital Libraries*, ser. Lecture Notes in Computer Science, vol. 2163. Berlin / Heidelberg: Springer, 2458, pp. 117–139.

[6] J. Bollen, S. Vemulapalli, and W. Xu, "Digital library evaluation by analysis of user retrieval patterns," in *Research and Advanced Technology for Digital Libraries*, ser. Lecture Notes in Computer Science, vol. 2458. Berlin / Heidelberg: Springer, 2002, pp. 161–171.

[7] S. Kim, S. Lele, S. Ramalingam, and E. A. Fox, "Visualizing user communities and usage trends of digital libraries based on user tracking information," in *Digital Libraries: Achievements, Challenges and Opportunities*, ser. Lecture Notes in Computer Science, vol. 4312. Berlin / Heidelberg: Springer, 2006, pp. 111–120.

[8] M. Sfakakis and S. Kapidakis, "User behavior tendencies on data collections in a digital library," in *Research and Advanced Technology for Digital Libraries*, ser. Lecture Notes in Computer Science, vol. 2458. Berlin / Heidelberg: Springer, 2002, pp. 231–243.

[9] F. Sparacino, "The museum wearable: real-time sensor-driven understanding of visitors' interests for personalized visually-augmented museum experiences," in *In: Proceedings of Museums and the Web (MW2002*, 2002, pp. 17–20.

[10] M. Hatala and R. Wakkary, "Ontology-based user modeling in an augmented audio reality system for museums," *User Modeling and User-Adapted Interaction*, no. 3-4, pp. 339–380, 2005.

[11] C. Edwards, "Another world," *Engineering & Technology*, vol. 1, no. 9, pp. 28–32, 2001.

[12] R. Freedman, *How to make real money in second life*. New York: McGraw Hill, 2008.

[13] S. Kumar, "Second life and the new generation of virtual worlds," *Computer*, vol. 41, no. 9, pp. 46–53, 2008.

[14] M. Macedonia, "Generation 3d: Living in virtual worlds," *Computer*, vol. 40, no. 10, pp. 99–101, 2007.

[15] J. Reisinger, "Mashing the real world with virtual worlds a monetizing opportunity," in *First ITU-T Kaleidoscope academic conference on innovations in NGN: Future Network and Services*, 2008, pp. 111–116.

[16] E. Reuters, "Second life tops 50,000 concurrency," 2008. [Online]. Available: http://secondlife.reuters.com/stories/2007/09/04/second-life-tops-50000-concurrency/

[17] P. Marty, "A second life of your museum: 3d multi-user virtual environments and museum," *Archives & Museum Informatics*, 2007.

[18] D. Nood, "Second life: The second life of virtual reality," 2008, retrieved October 20, 2008 from http://www.epn.net.

[19] A. Anagnostopoulos, "Global distance-based segmentation of trajectories," in *the twenty-fifth ACM SIGKDD international conference on knowledge discovery and data mining*, 2006, pp. 34–43.

[20] S. Elnekave, "A compact representation of spatio-temporal data," in *the seventh IEEE international conference on data mining*, 2007, pp. 601–606.

[21] J. Umiker and J. Sebeok, "Behavior in a museum: A semio-cognitive approach to museum consumption experiences," *Signifying Behavior*, vol. 1, 1994.

[22] J. Oberlander, G. Karakatsiotis, A. Isard, and Androutsopoulos, "Building an adaptive museum gallery in second life," in *Proceedings of Museum and the Web*, 2008, pp. 749–753, montreal, Quebec, Canada.

[23] M. Zancanaro, T. Kuflik, Z. Boger, D. Goren-Bar, and D. Goldwasser, "Analyzing museum visitors behavior patterns," in *User Modeling*, ser. Lecture Notes in Computer Science, vol. 4511. Berlin Heidelberg: Springer-Verlag, 2007, p. 238246.

[24] K. Sookhanaphibarn and R. Thawonmas, "A content management system for user-driven museums in second life," in *Proceedings of International Conference on Cyberworld*, 2009.

[25] R. Thawonmas, M. Kurashige, K. Iizuka, and M. Kantardzic, "Clustering online game users based on their trails using self-organizing map," ser. Lecture Notes in Computer Science, vol. 4161. Berlin / Heidelberg: Springer, 2006, pp. 366–369.

[26] A. Bollen and L. D. Pozzolo, "Analysis of visitor behaviour inside the museum: An empirical study," in *Proc. of International Conference on Arts & Cultural Management*, 2005.