A Content Management System for User-Driven Museums in Second life

Kingkarn Sookhanaphibarn and Ruck Thawonmas
Intelligent Computer Entertainment Laboratory
Department of Human and Computer Intelligence
Ritsumeikan University
Kusatsu, Shiga 525-8577, Japan
Email: kingkarn@ice.ci.ritsumei.ac.jp and ruck@ci.ritsumei.ac.jp

***Abstract*—Over two decades, a great expectation on digital museums has been addressed but most of them have been implemented based on web technologies. Emerging Second Life, which supports rich communication, virtual collaboration, and 3-D content creation, has brought a new platform to digital museums. As a result, a way to systematically manage and arrange a tremendous amount of information in SL museums is required. In addition, dynamic content and context to encourage audiences to return to the museum more frequently must be designed based on audience drives and preferences. In this paper, a Content Management System (CMS) of digital museums in Second Life is presented to cope with these issues. Six proposed modules are the integral parts of CMS to handle data mining approaches inspired by a visiting pattern retrieval system of audience activities and web-based recommender systems.**

I. Introduction

With a population in millions and a monthly growth rate of more than 20 percent, Second Life (SL) is a virtual 3-D world bursting with opportunities in areas such as collaborative learning, legal practice, corporate connections, and people [1]–[4]. Virtual World, also known as Synthetic World, is a computer-simulated persistent environment similar to Real Life (RL). Users in SL are called residents which are represented by avatars. Like most of other virtual worlds, SL can support massively multiplayer to be online at the same time. Over 50,000 avatars have been online simultaneously in SL as reported by Nino [5] since September 2007. SL provides a wide spectrum of online activities, including arts, science, sports, and education. Therein, the residents can explore, meet other residents, socialize, and participate in all kinds of activities [1]–[3], [6]–[8].

Currently, the number of existing museums in SL is greater than 150 locations, characteristics of which vary tremendously in term of scale and size, artifact types and exhibition, media technologies, and target audiences, as reported by Urban [9]. Among them, the most important characteristics are museum content and target audiences as a key role to increase the number of re-visiting audiences. Advanced technologies are feasible to provide a guidance of museum tour for an individual person, so-called personalization. Personalization system will filter and select, and then arrange information to maximize the visitors' satisfaction without spending too much time to indulge enormous information.

Fig. 1. A gallery in the Smithsonian Latino Virtual Museum (LVM) [10]

One challenge arises because 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 float in mid-air without suffering from theft or deterioration over time. However, the distance in SL is not a problem because a teleport feature allows residents moving from one location to another location in a second. For example, the easiest way to reach the gallery shown in Figure 1 is a teleportation by specifying the gallery location at $(120, 251, 34)$. A systematically personal guide for a museum tour in SL will be fruitfulness, which is a part of our proposed framework.

Another challenge is that of identifying and targeting specific audiences in SL. This is from the nature of interacting with individuals in SL, combined with the typical SL citizen reluctance to give out information about their RL identities, making 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

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more about their visitors in SL [11]. For example, EPN shows the number of residents who lied about their real gender is approximately 10 percent [12].

This paper presents a conceptual framework for managing the museum content and the user profile in SL. The goal of our Content Management System (CMS) is to personalize the museum content and context by detecting audience preferences. The proposed framework consists of two sub-systems based on a type of activities, consisting of visiting and participation sub-systems. The rest of the paper is organized in two sections. Section 2 describes the CMS modularization including the framework of visiting and participation sub-systems. Scenarios are also given elucidating our methodologies for personalization. Section 3 summarizes a paper and suggests possible future work.

II. Content Management System

To achieve high visitor's satisfaction, analyzing audience types is required. EPN [12] discovers that the motivation to participate in SL is diverse in the following descending order: (1) Fun (2) Doing things that cannot do in RL (3) Making friend (4) Learning and (5) Part-time. Audience motivation obviously supports that SL museums must encourage visitors to return again and again by analyzing their preferences. Relevant to the aforementioned personalization, there are two important databases containing museum content and user profiles. Moreover, these databases need to be dynamic whose mechanism is described later.

In the proposed Content Management System (CMS), six integrated modules are designed as follows:

1) Guide Avatar (GA) who gives an audience his/her personalized information of each artifact
2) Personal Route Generation (PRG) module for a museum tour
3) Customer Relationship Management (CRM) module
4) Audience Satisfactory Evaluation (ASE) module
5) Museum Content Adjustment (MCA) module
6) User Profile Adjustment (UPA) module

The guide avatar addressed in [13] can create a new text for each audience, at each time when he/she views an object. The guide avatar never repeats information which it has already expressed. For example, if an audience moves from one artifact to another artifact, both of which belong in the classical period; the guide avatar will not repeat the description on classical period at the latter location.

A personal route for a museum tour assists audiences in making a decision where they should stopover and how long they should take. Since audiences in SL can teleport to any place with a constantly short time, the PRG module for a museum tour is a novel concept in the personalization issue.

Like the business world, the CRM module plays a key role to encourage audiences to re-visit the museum. The CRM module sends newsletters to the target customers based on their preferences. The ASE module is for verifying the audience profile as well as adjusting the cost function in the CRM module. For the two remaining modules, i.e., MCA and UPA, the purpose of them is to adjust the databases of the museum and its users (or audiences) by analyzing the comment log from them.

A. Modularization framework

The audience activities in digital museums can be classified as follows with their percentage based on the '90:9:1 rule' for new social media [14]:

- Visiting, approximately 90% of users in SL just stops and looks around the exhibitions.
- Interaction, only 9% of users contributes from time to time.
- Participation, rarely 1% of users participates a lot and accounts for most contributions.

The proposed framework based on the above classification is divided into two sub-systems with the interaction and participation being grouped into the same sub-system. Museum-like activities in SL are mostly related to the social community and collaboration. Therefore, the interaction activity is considered a part in the participation sub-system.

The first sub-system, called *Visiting sub-system*, aims to personalize the museum content for everybody. Booth [15] describes three groups of virtual visitors as follows:

- General audience who requires general information such as notable exhibits and navigation aids in the museum
- Educated audience who requires (in addition to the above information for general visitors) more detailed information to help them plan their visits
- Specialist audience who requires (in addition to the above information for general visitors) more detailed information concerning museum's collections

In this sub-system, a personal map displaying a sequence of visiting galleries with specific stopover time is generated for an individual audience. Moreover, a personal guide in form of a guide avatar can illustrate the description of each artifact based on the knowledge background of audiences. Unlike the other modules focusing on the first-time visitors, CRM will encourage the audiences to re-visit the museum by analyzing their behaviors from the first visit and, sending emails on incoming events and exhibitions suiting their interests.

The second sub-system, called *Participation sub-system*, supports the part of the museum-like activities such as cafes, nightclubs, as well as seminar rooms. A large number of comments from those activities will be recorded in comment log. Thus, both user profile and museum content can be efficiently adjusted by analyzing the comment log. Content adjustment covers both new exhibition rooms and incoming events.

B. Visiting sub-system

At the first sub-system, a visit is also divided in two types as follows.

- First-time visitors, defined as unregistered users who walk into the general information hall through a main entrance.
- Repeaters, defined as users who previously visited the museum.

Fig. 2. Example of a general information hall

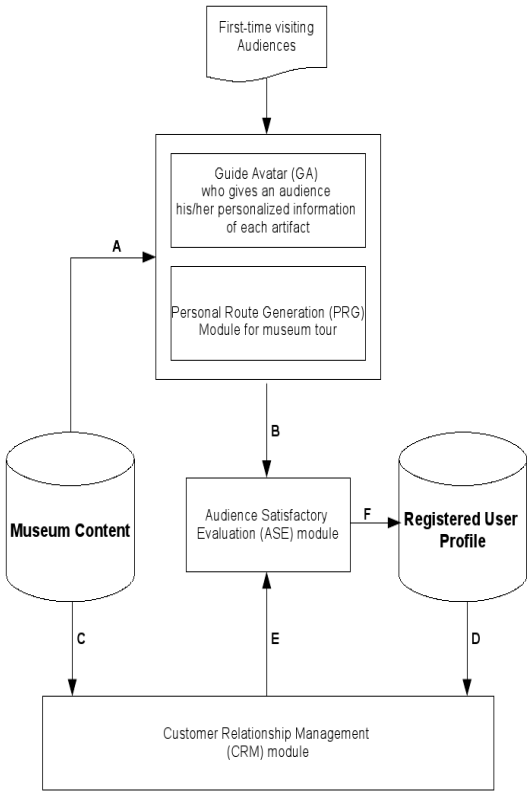

Fig. 3. Visiting sub-system diagram in Content Management System (CMS)

At the main entrance, a general information hall as shown in Figure 2, which displays masterpieces of each exhibition room, is placed to investigate the visitors' behaviors from their movements. An exhibition room is defined as an art gallery or a hall displaying a collection of artifacts in the same era. For example, a museum of Japanese history can be divided in the following periods: (1) Early Japan, (2) Nara and Heian Periods, (3) Kamakura Period, and etc.

Similar to several researches on analyzing navigation in virtual environment [16], [17], parameters to be considered consist of time spent, travelled areas, and seen points. Then, classification of audience levels into general, educated, and specialist audiences is conducted. In Figure 3, the proposed four modules, GA, PRG, ASE, and CRM, are integrated to personalize museum content.

The GA and PRG modules select and filter the museum content matching the audience preferences. To analyze the audience preferences, patterns of audience movements in the general information hall are detected and interpreted. In Figure 3, the arrow A indicates the parameters related to the museum content such as the types of collections, the room locations, etc. In case of the personalization system for the registered users, the CRM module distributes newsletters to those who are the target audiences by analyzing the museum content database and the registered user profile, denoted by the arrow C and D, respectively.

The arrow B in Figure 3 means the audience behaviors after receiving the personal route and guide whether they follow provided service strictly while the arrow E in Figure 3 shows the audience responses after receiving the newsletters whether they attend the events or the new exhibitions. Both data B and E pass through the ASE module to adjust the database of registered user profile with the output data denoted by F.

A personal map contains guided locations of a museum tour, which are different from each other. For example, three people who are recognized as general, educated, and specialist audiences will each receive one of three different generated routes. Table I illustrates three example routes for three first-time visitors, say, Ronaldo, Sam, and Tata, where $Loc.$ and $Time$ indicates the location of the recommended room and time spent, respectively. Without loss of generality, we assume that $Hall1$ - $Hall6$ are gallery halls in the museum and that Ronaldo, Sam, and Tata are specialist, educated, and general audiences, respectively. Their scenarios are given in Figures 4 - 6.

Ronaldo case: In RL, Ronaldo, who is a soccer superstar, has many collections of Japanese history related to Samurai since he was young. Every time, he would love to visit museums in Kyoto if his trophy tour is in Japan. In SL, Ronaldo signed in and teleported to the general information hall of Kyoto museum. Then, he wandered around the hall floor and suddenly stopped at the artifacts related to Samurai era. This case of passions belongs to specialist.

Fig. 4. Scenario of a specialist visitor

In additional, how to appeal to first-time visitors is not easy because none of their data is recorded. Patterns of visitor

Sam case: In RL, Sam, who is an undergraduate student in an Engineering school, always spends time in library. He is quite skeptical. In SL, Sam signed in and teleported to the general information hall of Kyoto museum. He began with the first artwork and reading the description note-card, then, moved to the next artwork, and so on. He skipped only a few of artworks and also kept reading all note-cards. This case of learning-willing motive belongs to educated.

Fig. 5. Scenario of an educated visitor

Tata case: In RL, Tata, who is the singer superstar, prefers to go shopping and touring than staying home. She never missed to have pictures wherever she has visited. She is often upset if she is not permitted to take a photograph. In SL, Tata signed in and teleported to the general information hall of Kyoto museum because of her friend's suggestion. Then, she wandered around the hall floor as well as left her avatar idle sometime. This case belongs to general.

Fig. 6. Scenario of a general visitor

Fig. 7. A cafe in the Smithsonian Latino Virtual Museum (LVM) [10]

movements in the general information hall can be classified as three visiting styles as follows.

- 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 educated visitors.
- 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 specialists.
- Users in swimming patterns are so busy that they possibly observe and learn the general information about the exhibits, which are belonging to the general visitors.

This visiting pattern classification addressed in [18]–[23] can be applied to this problem. The GA and PRG modules are the solution of the following questions:

- How is the route of museum tour arranged to shape the experience of visitors?
- How are the objects organized to shape the experience of visitors?

This is an assistant to achieve the goal of making the first good impression and encouraging the second visit. Besides the personal map, the guide avatar will follow the visitor to give a description with suitable vocabularies matching to his/her knowledge background. In a highly competitive world, the prospective museums require the CRM module to drive the registered users to return at their interesting events or exhibitions. Relevant to CRM implementation are data mining techniques, which Wu et.al. gathered and published in [24] as the top 10 data mining algorithms.

TABLE I
THREE DIFFERENT ROUTES FOR DIFFERENT PEOPLE, RONALDO, SAM, AND TATA CLASSIFIED AS SPECIALIST, EDUCATED, AND GENERAL VISITORS, RESPECTIVELY

Personal Route for Museum Tour					
Ronaldo		Sam		Tata	
Loc.	Time (min)	Loc.	Time (min)	Loc.	Time (min)
Hall V	30	Hall I	10	Hall I	5
		Hall II	10	Hall II	5
		Hall V	10	Hall III	5
				Hall IV	5
				Hall V	5
				Hall VI	5

C. Participation sub-system

The aim of the second sub-system is to adjust the museum content and user profiles based on the user comments. The user comments are collected from any social communities such as cafes, nightcubs, and discussion rooms. The participation-supporting environment must be well-designed for compelling users to join the museum activities. An example of a museum cafe is shown in Figure 7.

The participation sub-system shown in Figure 8 contains two integrated modules related to both databases: the museum content and the registered user profiles. The modules are similar to those of many previous researches on the visualization and discovery of user comments based on web log (blog). Relevant to the participation sub-system implementation are recommender techniques as discussed in [25] and techniques for visualization of discussions from user comments in [26].

In Figure 8, the Museum Content Adaptation (MCA) module discovers which objects in the museum content should be added, adjusted, or removed. Three input data consist of the comment log, registered user profile and museum content, denoted by the arrows A, B, and C. The arrow D indicates an output list of added, adjusted, and removed content of the SL museum. Similar to MCA, the User Profile Adaptation (UPA) module can update the knowledge background of registered users. Two inputs are fed into the UPA module, denoted by the arrows E and F, and an output, denoted by the arrow G, is a list of updated information for the corresponding users.

III. CONCLUSION

This paper presented a modularization framework of Content Management System (CMS) in SL museums. The main issue is how to manage tremendous information of museum

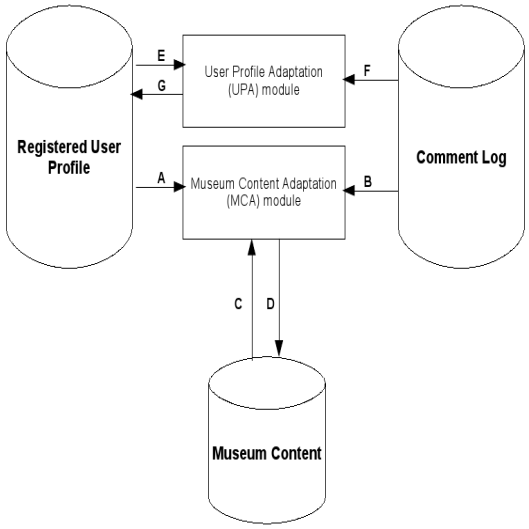

Fig. 8. Participation sub-system diagram in CMS

and personalize the appropriate information to an individual audience. The proposed framework consists of two subsystems and six modules, related to museum content and user profiles. The visiting and participation sub-systems focus on the personalization and user-driven museum content. Our technical approaches are borrowed from existing techniques such as those used in web-based recommender systems and visualization systems of comments in web log. However, these techniques need to be properly adjusted, and this task is left as our future work.

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