Abstracts of Digital Humanities 2011 (DH2011), Stanford University, CA, USA, pp. 365-368, Jun. 19-22, 2011.

Visualization of Visitor Circulation in Arts and Cultural Exhibition

Kingkarn Sookhanaphibarn, Ruck Thawonmas, and Frank Rinaldo

Intelligent Computer Entertainment Laboratory

Global COE Program in Digital Humanities for Japanese Arts and Cultures

Ritsumeikan University

kingkarn@ice.ci.ritsumei.ac.jp, ruck@ci.ritsumei.ac.jp and rinaldo@is.ritsumei.ac.jp

1. Introduction

The topic of visitor circulation in museums and art galleries has been considered as an important factor in all aspects of the museum experience [1-3]. Circulation describes how visitors explore a set of exhibits in a particular space by observing what pathways the visitors take. A visualization of visitor circulation can confirm whether visitors circulate the way the designers intended. The visualization can assist the designers to arrange a predefined pathway so that visitors will not miss key exhibits. The well-designed circulation system can also increase the great number of return visitors.

Sookhanaphibarn and Thawonmas [4] proposed the local and global visualizations aims at presentation and analysis of visitor behaviors in 3D virtual museums. The visitor path is displayed with a spectrum of colors in the form of connecting segments from red to violet. The color of a particular segment indicates the passage of time. The drawback of these visualizations is that they were strictly overlaid on the layout map. To deal with the varying layouts commonly found in a museum with many exhibition rooms, visualizations with an independent layout is an alternative assistant tool for the visual analytics of circulation patterns.

In this paper, we proposed a new visualization tool to represent a visitor path and his/her time spent residing near the closest item. We encode a time interval residing in an item boundary into a color-shaded line segment. Color shade is used as an indicator of the proximity to the nearest item. The length of a segment is in proportion to the total time spent in the layout. The time segment is placed in the row corresponding to its item boundary. A path of visited items is illustrated by connecting the time segments with vertical lines.

With the proposed visualization, we can easily find the trend of visitor circulation which strictly follows the pathway designed by a curator. The trend is represented by the white line, called “Forward”, running from the most left above to the most right bottom corners as shown in Fig. 1. There are the other trends, which are called “Backward”, “Bell” and “Inverted bell”, possibly influenced by the visitor characteristics and/or preferences. The similar trends of visitor circulation will be explained later in detail.

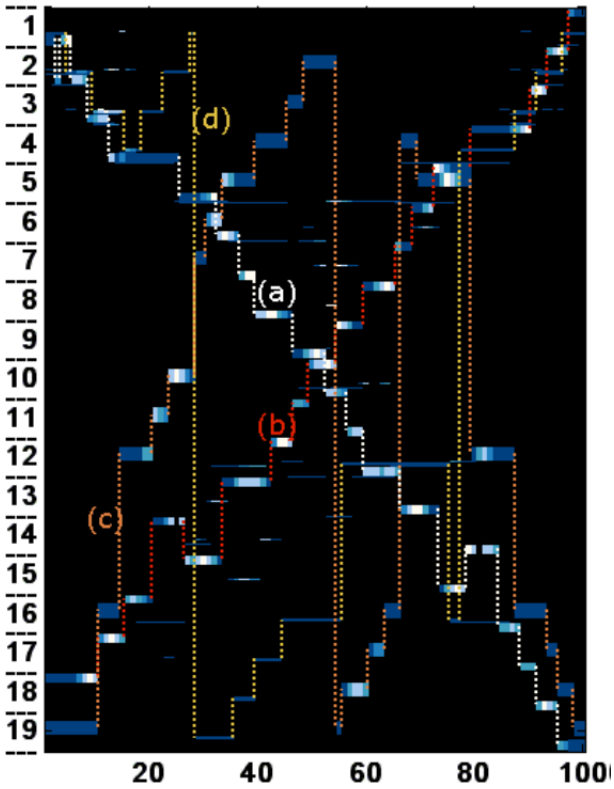

Fig. 1. Four trends of circulation: (a) Forward, (b) Backward, (c) Bell, and (d) Inverted bell.

Layout-dependent visualization

Most visualization techniques using traditional two dimensional maps represent visitor trajectories and their corresponding visit time directly over spatial layouts. In this paper, we call layout-dependent visualization as any visualization technique using the spatial layout of a target area as its graphical background in visualization. With the layout-dependent visualization, a circulation

pattern is not easily extracted by a user who is not familiar with the target layout map.

The layout-dependent visualization approach burdens users with a cost of requiring them to recognize the layout of items and routes by themselves. Some additional symbols indicating the position and boundary of items as well as arrowheads indicating representative routes must be placed in layout-dependent visualization. However, these symbols and arrowheads conceal visitor traces from users.

2. Design Decision

This paper considers the use of a layout-independent display for visual analysis of the path and residing time of the movement data in circulation, named "PARTY". PARTY is an abbreviation of Path And Residing Time display. Taking for example a museum in a 3D virtual world, the circulation behaviors of visitors moving through museum of interest are influenced by the items on which the visitors focus their attention.

Designers of a musuem space require serveral types of information when examining the circulation behavior of visitors. These include (1) residing locations, regions, or item boundaries, (2) visit time intervals near an item, (3) paths of visited regions, (4) global information showing multiple visitors residing in a region, and (5) degrees of their interest. All of these information types are derived from two data sources: (1) a log file of visitors' positions including x-y coordinates and time and (2) the map of a museum or a floor plan, where the location of items or the position of rooms is provided at least.

The design of PARTY aims to represent three dimensional entities, i.e. a time unit, a visited item, and a visitor. The horizontal and vertical axes of PARTY represent time and items which visitor moves through their boundaries. A stack of visitor stripes is put inside an item block (row). As shown in Fig. 2, there are five items of interest and three visitors. The stack of three visitor stripes places inside each item row. The order of three visitor stripes is consistent thorough five item rows. Therefore, an PARTY entity represents a visitor *v* who stays near item *X* at time *t*.

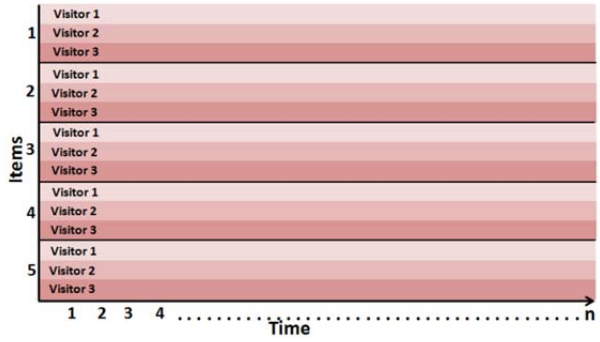

Fig 2. A structural design of PARTY.

We arrange the visitor stripes in every stack in the same order and rank them by the similarity among their present circulation patterns. Then, we use the hierarchical clustering technique for finding the similarity of all pairs of visitor paths. To handle hundreds of visitors, the representative of each group of visitors can be used rather than a single visitor. The representative is derived from the generalized median defined as the visitor path having the nearest distances to all.

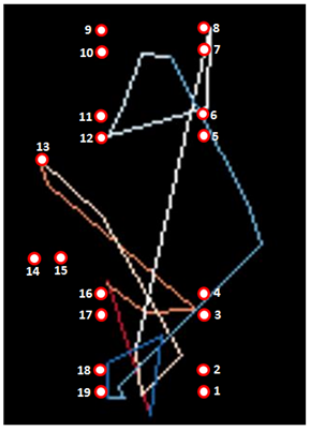

Fig 3. A representation of a visitor trace tracked in a 3D virtual museum.

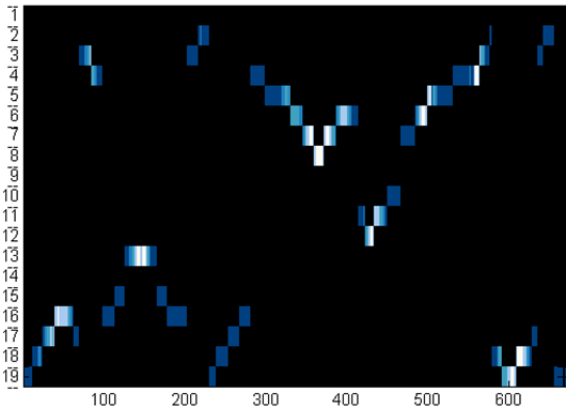

Fig 4. Transformation of a single trace (Fig 3.) to PARTY representing the path of visited items (y-axis) and his/her interest to items by using color shades from brightness to darkness (highest to lowest degrees).

Besides a path of nearest items versus time, the proximity distance to the nearest item can be displayed in PARTY as a degree of visitor's interest to each exhibit item. A displaying color is computed using the observation distance and range based on the location of all items. For example, given the visitor trace as shown in Fig. 3, Fig. 4 represents a visitor trace as our observation-based time series. The visualization in Fig. 4 consists of the horizontal axis corresponding to the visit time, the vertical axis indicating an item belonging to the observation range at a particular time, and the

color showing the observation distance. This visualization is produced by using the observation distance and range in the application of a 3D virtual museum.

3. Results and Implications

This section presents an application of PARTY analyzing the avatars' trajectories and finding trends of circulation behaviors in the 3D virtual museum, named RDAP. RDAP, owned by the Global Center of Excellenct in Digital Humanities Center for Japanese Arts and Cultures, of Ritsumeikan University, was created in Second Life. An objective of RDAP is to disseminate Japanese costumes, Kimonos, preserved them in a digital achieving system. We synthesize the visitor trajectories based on the metaphor of four animals as mentioned in [4]. The total number of synthesized trajectories is 36 where each visiting style has 9 trajectories.

Similar Trends of Circulation Patterns

After applying the PARTY approach, visitor trajectories are transformed into time series data. Discovering similar trends of circulation patterns is achieved by a traditional dynamic time warping followed by the hierarchical clustering. Then, generalized median of each resulting cluster is calculated. Fig. 1 shows four trends of circulation patterns including:

a) Forward circulation: this trend illustrates that visitors prefer to turn right at entrance and move following the curators-guided path from the the fist to the last items.
b) Backward circulation: the direction of this circulation is backward from the forward one, i.e. turn left at the beginning.
c) Bell-shape circulation: visitors in this trend prefer to start and end their visit with the same item, and they turn right at entrance.
d) Inverted bell-shape circulation: This trend pattern is similar to the bell circulation but they turn left at entrance.

The other view of PARTY displays a stack of representative stripes of which the width denotes the size of their categories. The bell-shape circulation has the largest number of visitors followed by the backward, forward, and inverted bell-shape circulations, respectively.

References

[1] Bitgood, S. (2006), An Analysis of Visitor Circulation: Movement Patterns and the General Value Principle. Curator: The Museum Journal, 49: 463–475. doi: 10.1111/j.2151-6952.2006.tb00237.x

[2] Guy, G., Dunn, S. and Gold, N. (2010), "Capturing Visitor Experiences for Study and Preservation", In *Digital Humanities 2010, Conference Abstracts Book*, pp. 160-162

[3] I. R. Kaynar, S. Psarra, and J. Wineman. Experiencing museum gallery layouts through local and global visibility properties in morphology: an inquiry on the YCBA, the MoMA and the HMA. In Proc. 7th International Space Syntax Symposium, Stockholm, Sweden, June 2009, pp. 1-16.

[4] Sookhanaphibarn, K. and Thawonmas, R. (2010) "Visualization and Analysis of Visiting Styles in 3D Virtual Museums", In *Digital Humanities 2010, Conference Abstracts Book*, pp. 239-243