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Preprint

This is the submitted version of a paper presented at *CyberWorlds2016*.

Citation for the original published paper:

Hayashi, M., Bachelder, S., Nakajima, M. (2016)
Automatic Generation of Personal Virtual Museum.
In: *Proceedings of CyberWorlds2016*

N.B. When citing this work, cite the original published paper.

Permanent link to this version:

<http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-314241>

Automatic Generation of Personal Virtual Museum

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Abstract— We have developed a Virtual Museum with real-time 3DCG capable of exhibiting arbitrary planar artifacts such as paintings which have been specified by a user. The pictures are collected from the Internet sites such as Wikimedia Commons by giving bookmarks by the user. The artifact images are displayed in its life size automatically aligned on the wall of the museum with picture frames and generated captions. This process is done based on metadata extracted using a technique called Web scraping to extract necessary information from the target Web sites. The museum space is realistically modeled with high resolution and sophisticated illumination where the user can walk through in the space. The system enables the users to create their own personalized museums with their favorite pictures exhibited in the realistic way.

Keywords—CG, Virtual museum, Digital heritage, Virtual reality, Automatic content generation

I. INTRODUCTION

Museums have been evolved for a long time as "Facility" in many ways. What we propose in this paper, is the "Museum" itself. We museum lovers have a variety of favorite artifacts for our own. And some of us may want to construct our own personal museums full of their favorite things. That is the very concept that we propose here. We have developed the personal virtual museum made by 3D Computer Graphics (CG) which is automatically generated only by pressing a button of the application after you tell your desired artifacts to the system. (Fig. 1).

Services of creating customizable virtual museums for individual users, had been popular one time in the past [1]. It was the era of "Web2.0" [2] which was originally proposed to

provide customizable Web contents. Once in a while, many museums in the world provided such services in their Web sites. The service was done through the process such that users login to create the accounts, bookmark the artifacts on the museum home page, then the users can see them together later on the Web browser. This type of service is derived from the concept of customizable Web contents (e.g. My Yahoo). However, this had not invoked much excitement to the users. After the several years, the customizable museum services began to get out from our sight. In place of the customizable museums, the next trend of virtual museum went toward plenty of IoTs (Internet of Thing) and VRs (Virtual Reality) and ARs (Augmented reality) which brought "Interactivity" into the museums [3]-[5].

One of the reasons why the customizable museum was not very popular is lack of fun. The service itself was quite useful for educational purposes [1] however the ordinary users did not see any attractive things in it. That is because the services merely provided users' favorite images gathered simply as thumbnails on the Web browser where it should have given the user experience by providing a virtual museum decorated with their own collections intrinsically.

On the other hand, there were some other virtual museum services using real-time 3D CG [6]. However, the most of them provided some kind of VR applications which failed to appeal its charm of the museums themselves. Furthermore, the walk-through method employed in those services was more or less the one used in First Person Shooting (FPS) games. It was not specialized for museum appreciation.

Based on the background mentioned above, we have thus attempted to rebuild the customizable virtual museum in a more sophisticated way. The first most important premise of our virtual museum development is to design the museum enabling users to appreciate the artifacts as if they are walking in the real museums, seeing the works in a much comfortable atmosphere. We prioritize the ambient of the museum space. And the space packed with too much information as possible to force users to interact with, is carefully avoided. In that sense, we first learn how the traditional real museums manage the exhibitions, and the obtained know-hows are then applied to build our digital museum. Our goal is to create a virtual museum exhibition as a self-sufficient "Artifact" that can stand on its own unlike the one just providing the images of the artifacts listed on the Web browser.

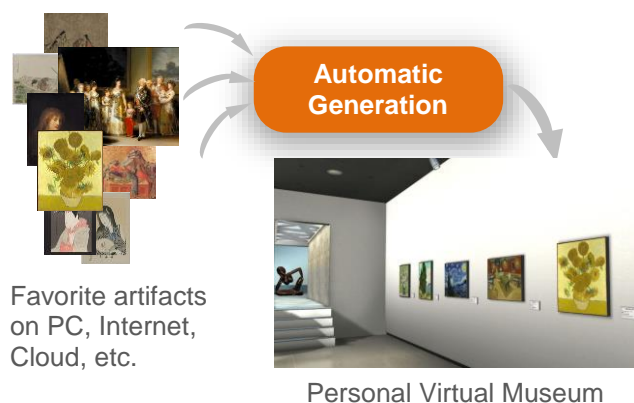


Figure 1. Concept of the personal virtual museum

In the following chapters, we will describe the prototype of our personal virtual museum generated automatically from the users' input.

II. MECHANISM OF THE PERSONALIZABLE MUSEUM

In the current prototype, we cover only artifacts of planar pictures for the display in the museum. The user input is image data files and metadata that comes with the images. Based on the input, the system automatically creates a procedural environment with 3D CG with flexible walls changing its space in accordance with the specified paintings displayed. The input images then are pasted onto panels along with captions that are automatically generated from the metadata. Those are then aligned at appropriate intervals on the walls of the space. Finally, the user can see the PC monitor displaying finished museum space with those artifacts freely walking through with a mouse.

The system provides several ways to specify the displayed images. The most significant way is to use Wikimedia Commons for this purpose. Users select favorite images from the Wikimedia Commons [7] and bookmark them to the Web browser. Then, the system reads the stored bookmark to download the corresponded image data and the metadata and then those are automatically placed in the 3D CG museum space.

III. DESIGN DETAIL

A. Space and the system design

The museum space is designed as a modern art museum appearance (see Fig. 2). The modeling was diligently done to achieve the reality as much as possible to let the user enjoy the atmosphere. We use the Unity Game Engine [8] as the development environment. In order to accomplish the museum space in reality, functions such as the Global illumination and the Physical-based Shading are abundantly used to obtain the appearance of a space with the external sun light. In addition, the naturalness was pursued in designing by increasing the resolution of the texture even for the walls. Ordinary museum space has a large empty area except the displayed artifacts and the people surely focus on the target objects, however we assume that the people can feel its ambient while seeing the targets together with plenty of detailed elements including the texture of the wall, lighting condition and shadow and shading induced by the external light sources and so on. We aimed at



Figure 2. *Designed museum space*

achieving those important elements without neglecting the details.

The size of the room is variable. The four walls surrounding the space are movable and the size is automatically calculated based on the size and number of displayed images. It is generated in the procedural way by a computer algorithm.

B. Image files

The input image is put onto the front surface of a panel previously modeled and it is aligned on the wall with casting shadow as if the real thing is displayed there. In addition, the artifact is displayed in its original size. The size is obtained from the metadata described later.

C. Captions

Captions are automatically generated from the later-described metadata. Learning from captions commonly used in real museums, an artifact name, an author's name, a date, a medium, etc. are printed on the caption plate. The caption is allocated on the wall in the appropriate position with respect to the artifact image panel.

D. Metadata acquisition

Metadata is associated with its image data. Important aspects of the metadata are the actual size of the work and a description of the work. The system manages those as an XML format. When the museum is generated from the bookmark of the Wikimedia Commons, the metadata is extracted from a HTML of the page using the "Web scraping" technique. Fig. 3 shows the page of Wikimedia Commons describing auxiliary information related to the target work. Because the way that individual people edited the page is not coherently followed the unified way of writing, the heuristic approach of Web Scraping is applied to extract the necessary data, thereby to generate the XML metadata. Besides the artifacts data is made from Wikimedia Commons, those data can also be prepared manually. In addition, if there is no XML data, the image is displayed in a default size and the caption indicating just the image file name.

E. Walk through

The system has two modes of walk-through when a user


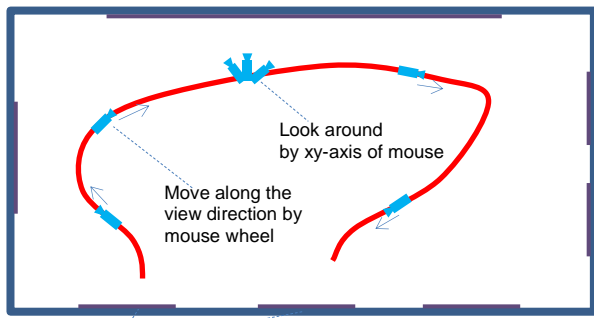
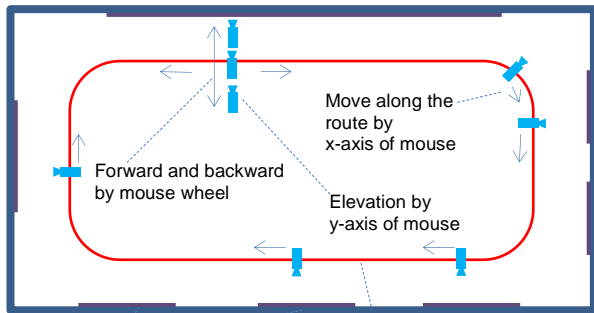
Artist	Vincent van Gogh (1853–1890)    
Title	Deutsch: Selbstporträt, Gauguin gewidmet English: Self-portrait, dedicated to Paul Gauguin Français : Dédié à Gauguin Nederlands: Opgedragen aan Gauguin Polski: Dedykowany Gauguinowi 
Date	September 1888
Medium	oil on canvas
Dimensions	62 × 52 cm (24.4 × 20.5 in)
Current location	Fogg Art Museum, Cambridge MA,  United States
Accession number	F_476 JH_1581
Source/Photographer	Web Museum   [1] 

Figure 3. *Relevant information segment on the Wikimedia Commons*



Artifacts
(a) First Person Shooting (FPS) mode



Artifacts Route (pre-defined)
(b) Appreciation mode

Figure 4. Two switchable walk-through modes

operates the application by a mouse (see Fig.4). These modes can be switched at any time by pressing a mouse left button or a space key. The modes are: (a) First Person Shooting game mode: looking-around by XY-movement of a mouse, traveling in the direction you are facing by a mouse wheel, (b) Appreciation mode: Moving forward and backward along the previously defined route in the room by a mouse, moving closer or further the target image by a mouse wheel. The mode (a) is suitable for moving freely in the 3D space but not good for viewing a specific painting. On the other hand, the mode (b) is suitable for viewing the target painting by magnifying, shrinking and scrolling the image but does not have much freedom when moving in the 3D space. By switching the two modes appropriately, the user can walk around the 3D space in the mode (a) and can also observe the detail of a specific painting intensely in the mode (b). In addition, the movement of the virtual camera is forced to move smoothly and slowly by using a servo lock mechanism to the camera realizing the spacious movement.

F. User interface (UI)

The UI is simple (see Fig. 5). According to our design concept, we pursue how much we can reduce the stress posed on the user. The user only chooses their favorite museum collection from the menu. There are following three choices: 1) a preset of the collection, 2) to select a bookmark of the Wikimedia Commons that the user have made the choice, and

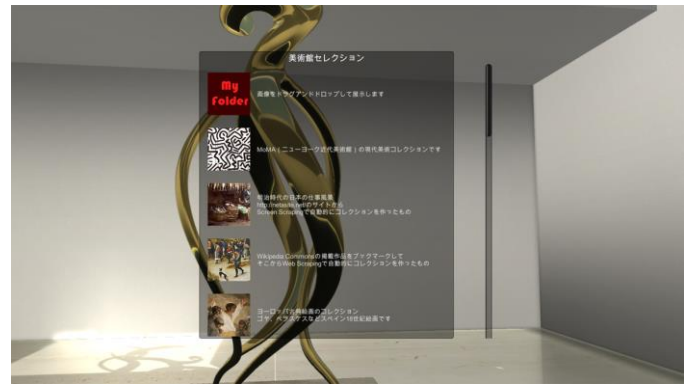


Figure 5. Selection menu to choose from collections

3) to drag and drop your image files on a hard disk that you want to display.

G. Other features

We provide some features other than the walk through of the museum to see the pictures. On top of an artifact being viewed, a commentary text can be overlapped which is written in the metadata by pressing a button. Also the text-to-speech of the commentary is available. Three-dimensional objects such as sculptures can be presented in the space in advance so that a user can appreciate it freely from the 360-degree direction. (Currently, however, 3D object data cannot be dynamically imported from external sources.)

IV. THE EXPERIMENT

Fig. 6 shows some screenshots of our virtual museum. The museum was presented in several exhibitions. We obtained positive feedback from visitors. Our core idea of the capability of creating the personalized museum from users' preferences impressed the people. They mentioned its potential to apply this to many types of feasible services such as a personalized photograph museum service. Regarding the walk through method, even though it takes some time to get used to it, but it is convenient to move in the space and to observe the artifacts freely only with one hand.

One might say that it is just a simple technology to put pictures side by side on the walls of 3D CG space and providing a way to walk through. However, we claim that the important point of our development is to achieve overall quality by integrating and balancing many small but critical elements such that to paste the image onto the panel with casting shadow with a caption simulating the one in a real museum exhibition, to display all of them in life-size, to use high-resolution textures and sophisticated lighting effects to make it real and so forth.

V. CONCLUSION

We have developed the personal virtual museum with 3D CG automatically generated from a bookmark of the Wikimedia Commons where a user has picked up their favorite pictures. The user can walk through in the virtual museum space freely to appreciate their favorite pictures. We have successfully made the first step toward the Full-Personalized Virtual Museum.

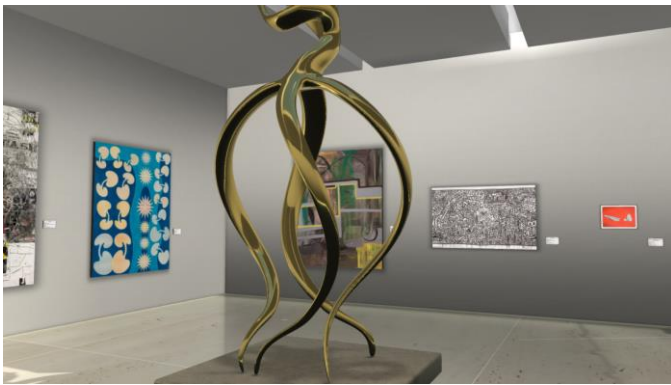


Figure 6. Screenshots of the museum

We have many future challenges. First of all, we need to evaluate the advantage of our system by performing both qualitative and quantitative experiments. Also we have much plans in development. The application should work on a tablet and a smartphone although it now works only on PC. The operation device should be a touch panel instead of a mouse obviously. The application should be remade as an installer package so that users can download it and can install it on their PCs to enjoy it. In addition, the image data and metadata should be prepared in advance on a server so that users can choose the one to see the recommended exhibition. It would be also necessary to create multiple rooms connected each other via entrances. Three-dimensional objects and videos should be allowed to be displayed in the same way as the pictures.

We will evolve the application that anyone on the Internet can use it to make their personalized virtual museums. In any case, we should carefully observe a variety of exhibition know-hows in real museums all over the world then to simulate them one by one transferring the techniques to the digital world. Our aim is to realize the Virtual Reality with a capability of personalization and customization that the digital technology is very good at. We believe this approach becomes increasingly important in the technology oriented 21st century.

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