EUROGRAPHICS Workshop on Graphics and Cultural Heritage (2023)
H. Graf, S. Pescarin, and S. Rizvic (Editors)

Interaction Styles in a Multi-Modal Virtual Museum

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Figure 1: *Stuart Era Virtual Museums: Standard (Left), Virtual Reality (Middle), Natural Interaction (Right)*

Abstract

Virtual Reality is used for creating immersive experiences with rich interactions in many application domains, from video games, simulations, and training, to cultural heritage and educational applications. Taking advantage of this technology, the experience in traditional museums can be enhanced with digital content, the museum or their collections can be replicated for remote visitors, or entirely new virtual museums can be created. In this paper, a demo of a multi-modal virtual museum is presented and interaction discussed from the point of view of a consumer and a virtual museum creator.

CSS Concepts: Human-centered computing → Interaction design →Interaction design process and methods

Keywords: Virtual Museums, Interaction, Natural Interaction, Cultural Heritage

1. Introduction and Background Work

Museums have long been used to present Cultural Heritage artefacts to the public. With the limited physical space and requirement for being physically present [HGLS22], the degree to which a user can interact with artefacts or visit exhibits is severely limited. To overcome these limitations, new technologies can be used to create virtual museums (VMs) and present cultural heritage content in a digital format due to their role as complicated communication systems, with ties to narrative, interaction and immersion [Pes14]. Furthermore, the enhanced interaction offered by the technology can have a positive effect on user experience and engagement with the content and aim to improve the visitor's experience [BCMR21]. However, the interaction and user experience of VM creators should be equally considered. This has lead to consumers moving from passively interacting with museums, to being active participators in their museum experiences, known as "Active Visiting" [NP19]. By utilising technology such as Virtual/Augmented/Mixed Reality (collectively known as eXtended Reality, or XR), hand tracking, speech recognition and other means of interaction [LK10], traditional museum exhibits can be greatly enhanced and the interactions can become more immersive, natural and exciting to use [BPF*18] whilst also removing the need for physical input devices and allowing for interfaces that go beyond the traditional WIMP approach [PPR*13]. Finally, to overcome the lack of tactile feedback in VR applications, passive haptic feedback and tangible user interfaces can be successfully utilised [HGLS22].

In this work in progress, a multi-modal VM based on the first half of the Stuart era in Britain (1603-1649) has been developed, using a variety of methods of interaction. The main goal was to explore these interaction styles and challenges with developing such an application, while focusing on the immersive experience. Designing interactions is absolutely vital, as the average user may not have much experience with virtual reality or multi-modal experiences. Therefore, the interactions need to be easy to learn and ideally close to real-world interactions.

2. Consumer Interaction in the Stuart Era Virtual Museum

The developed VM has three different modes of interaction: *Standard Mode(S)* - the museum is controlled with an Xbox gamepad and viewed on a monitor; *Virtual Reality (VR)* - the museum is experienced using a Virtual Reality (VR) headset, controlled with

Exhibit	Description	S	VR/NI
Pick Up Artefacts	Objects to be picked up and examined.	User can pick up, scale and rotate the object, as well as request information via the D-pad	User can pick up the objects using the VR hands (either controller or tracked) and can request information by speaking the relevant keywords for that object
Portraits	Portraits of key figures	User can request information about the subject of the portrait via the D-pad	User can point at keywords (either using a VR or tracked finger) and request information by saying ``Tell me about this'', or by speaking the relevant keywords for that subject
Timeline	Time periods controlled via slider	User can increment or decrement the slider to view its contents via the D-pad	User can increment or decrement the slider to view its contents by pressing the in-world buttons, with either their controllers or their tracked hands. Alternatively, speaking the relevant keywords can increment or decrement the slider
Diorama	Small scenes that the user can enter and walk around in	User can enter the diorama via the D-pad, as well as request information via the D-pad	User can enter the diorama with the ``opening'' hand gesture (either use the controllers or tracked hands) and can request information by using the relevant keywords for the diorama

Figure 2: *Exhibits within the VM and the associated interactions*

VR controllers and speech recognition using a microphone; *Natural Interaction (NI)* - similar to the Virtual Reality version but the VR controllers are replaced with hand tracking. The user is presented with four varieties of exhibits, each with different methods of interaction (see figure 2)

Additionally, the VR/NI modes use teleportation for locomotion and an interactive guidebook to view text-based versions of the information they asked for, view the associated keywords or for a tutorial refresher.

Whilst developing a multi-modal VM, many challenges and questions arose. One such challenge was designing the interactions to be as natural as possible [GC19]. Not all the potential users of such experiences may be comfortable with how to efficiently use a gamepad or VR controllers. The VR and NI modes offer the possibilities of natural interactions, which has it advantages and disadvantages. Some interactions are more obvious to use than others, such as picking up for the Pick Up artefacts or pointing motions for portraits. However, interactions that do not have a direct one-to-one mapping with the real world, such as entering the diorama exhibits or teleporting using only hand gestures required more consideration.The solution here was to use a combination of well-known gestures (pointing, speech recognition and a thumbs up motion for hand tracking based teleporting) or to pick a more abstract concept (opening curtains for the dioramas).

On the contrary, using a gamepad does not provide the same level of immersive interaction and provides its own set of challenges. There is a learning curve associated with using a gamepad, like the Xbox controller. Some users, particularly those without experience in gaming, may struggle to grasp how to use the gamepad altogether, including understanding the button layout and purpose. Nevertheless, it was anticipated that this was a more acceptable option than going with the keyboard and mouse mode. The gamepad allows for buttons to be grouped together (the bumpers and triggers, for example). This allows for similar interactions (such as rotating left or right) to be tied to a group of buttons and therefore making the interaction easier to remember.

Another challenge comes in the form of reliability of the devices used to allow for said interaction. At the lower end of the spectrum in the *Standard Mode*, the gamepad itself is generally a reliable input device. However, as we move towards input methods that are more complex, other issues become more likely to occur, such as the tracking with the VR headset, the VR controllers or the hand tracking. These not functioning as intended would seriously impede the application and user experience. In addition, it could be time consuming to solve the issue, which is not ideal if this application were to be deployed to an institution like a museum.

3. Creators' Interaction and Co-creation

Creating interactions and experiences for consumers (e.g. museum visitors) is very different to creating them for creators, such as (virtual) museum curators. Consumers are mostly worried about consuming the content, whereas the creators need to not only design interactions and experiences for consumers having the end-user's experiences in mind, but must also be able to interact with authoring tools while having good user experience themselves. These introduce a new range of interaction questions. What interactions are key for allowing creators to build virtual experiences? What would be required to provide creators the confidence to build the experiences? How useful XR authoring tools are to curators, what kinds of experiences could they build with such tools, and to what degree of exhibition creation independence can be feasibly achieved?

Some work has been conducted in this field, both aimed towards end users authoring their own VMs (VR and Non-VR) using knowledge graphs and linked open data [MPSV22] and towards curators authoring their own tangible interactive exhibitions [NP19]. One of the primary issues and concerns of technology-based authoring tools is the confidence of the end user, in this case, the museum curator. During the MeSCH project, Cultural Heritage professionals expressed their concerns regarding their technological abilities but were excited at the prospect of experimenting with the MeSCH platform [NP19]. From this, we can clearly see there is an interest in tools for creators but the interactions would need to be chosen and developed with care, especially if this tool were to be developed as an XR authoring tool. Interactions designed as counterparts to real-world interactions, such as pointing at an area to place an exhibit, may prove beneficial for users who are not confident in their own technology skills. In an XR authoring environment, this could have the potential to speed up the prototyping or creation workflow, whilst making the interaction for creators much simpler to use.

4. Conclusions and Future Work

In this paper, we presented a work in progress on creating a multi-modal VM focusing on various interaction styles for the consumer. In addition, we discussed some limitations of the existing CH authoring tools and the important aspects to consider when designing novel XR authoring tools.

In the future, we plan to conduct a user study on usability and UX for the developed VM. Based on these results and the existing findings, we will propose a set of interaction techniques to be used in XR authoring tool for VM curation.

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