

# Analysis on user Interaction in Virtual Heritage: Virtual Museum Environment

Normala Rahim\*, Tengku Siti Meriam Tengku Wook and Nor Azan Mat Zin

Universiti Sultan Zainal Abidin, Universiti Kebangsaan Malaysia,  
Malaysia;

normalarahim@unisza.edu.my, tsmeriam@ukm.edu.my,  
azan@ukm.edu.my

## Abstract

The paradigm of interaction between humans and computers has shown changes to the new paradigm of interaction in line with the rapid development of advanced technology in Human Computer Interaction (HCI). The motivation of this study is based on a report from the New Media Consortium in 2015 which shows the importance of cultural heritage by presenting the expected development of technology that can be referenced by museums to upgrade an existing virtual museum system in order to optimize its use by visitors. However, a new interaction paradigm is still in the experimental phase and is not yet widely implemented. The preliminary study was conducted to analyze the key issue that still exists with virtual heritage in the technological aspect and evaluation. Qualitative data collection through interview was used in this study which involved 10 respondents. The findings show aspects of storytelling, interface design and evaluation of user experience as key issues that still exist in the virtual inheritance.

**Keywords:** Human Computer Interaction, Natural User Interface, Storytelling, User Experience

## 1. Introduction

Nowadays, the way people interact with computers has shown changes to the new paradigm of interaction known as Natural User Interfaces (NUI). The evolution of interaction begins with the Command-Based Line (CBL), Graphical User Interface (GUI) and Windows, Icons, Menus and Pointer (WIMP). However, with the rapid development of advanced technology, people are now able to interact with computers naturally like human interaction with other humans. This is proved by the progress of NUI that is the focus area of the research and it results in

a new device that supports NUI paradigm to help people interact.

According to<sup>1</sup> NUI means that there is no uniqueness but it has the same purpose of allowing people to interact with the computer easily, intuitively and flexibly without the use of additional devices worn on the human body that causes users to feel uncomfortable to interact. Nowadays, NUI has been widely implemented in many applications of virtual environments, games and serious games such as in areas of entertainment<sup>2,3</sup>, medicine<sup>4,5</sup>, data analysis<sup>6</sup>, cultural heritage<sup>7,8</sup>, education<sup>9,10</sup>, etc. Changes in the new paradigm of human computer interaction provide comfort and convenience to the user in interacting.

\*Author for correspondence

However, researches in Human Computer Interaction (HCI) that have been produced by many researchers are more focused on aspects of usefulness and usability<sup>11-13</sup> but does not take into account aspects of the user experience including aesthetic qualities, expression of motor or psychological reactions, and evaluation of cognition and behavior<sup>14</sup>.

Therefore, these researches focused on the field of cultural heritage including museums, historic sites and the like are within the category of tangible heritage. According to<sup>15</sup>, the new changes to the application interface and interaction has been proved very useful when applications no longer use physical input devices. A traditional input device consisting of a mouse, joystick, trackball, and keyboard are likely complicated to use and difficult to maintain<sup>16</sup>. So, Gesture-Based Interaction (GBI) has the opportunity to be a method of interaction that is simple and intuitive for users to interact with virtual heritage. GBI is one of the methods in NUI. However, application of GBI in the area of cultural heritage is still in the experimental phase<sup>12</sup>.

The motivation of this study is based on a report from the<sup>17</sup> that demonstrates the importance of cultural heritage by presenting the expected development of technology that can be referenced by the museum to upgrade an existing virtual museum system in order to optimize its use by visitors. The projected technological development in the museum has been made for the period 2016 to 2020.

The structure of this paper is as follows: Section 2 gives a brief background of the study. Section 3 highlights the methodology used in the study. Results and findings of the study were elaborated in Section 4 followed by the discussion and conclusions in Section 5.

## 2. Background of Study

Virtual Museum is an alternative to a museum in digital form with virtually the same aim as a real museum which is to showcase a museum's collection in turn to provide knowledge to visitors through informal learning. Nevertheless, a Virtual Museum has the advantage of acting as a safe storage in the event of natural disasters. In addition there are much research has been produced in the field of heritage, especially in the domain of Virtual Museum however it still have some constraints that have been faced by the public, especially visitors. One of the constraints is, most historians<sup>18,19</sup> state that interactive visualization is highly appreciated and important to users, but, delivering content in an informative interactive visual is not enough but needs added narration and knowledge<sup>20</sup>.

Another aspect is the presentation of information that can provide important points that are related to the collection to visitors is still ignored by most museums institutions<sup>15</sup>. It is a point of interest for visitors to know more beyond the artifacts on display, so that they may know the origins of the artifacts. The question of what they should know about the artifacts, how to relate to their culture and why it is important to relate to their origins should be considered to provide added value to the visitors. Therefore, with the development of virtual reality technology, more informative and valuable artifacts may be expected to be presented to visitors, and as a result, it can increase the time period of interaction between visitors and the artifacts.

Moreover, a collection of artifacts, historic sites, etc.<sup>20</sup>, are only exhibited as a catalog concept where visitors can only see and get simple such as the name of the artifacts, location found, function and materials used, but, the visitors are not given information about why the preservation

of artifacts and historic sites has value to present and future generations. An effort to preserve and share digitally is supported by the latest technology, but until now, digital cataloging of artifacts to content changes that have meaningful story has been ignored. The narrative element in the interaction between visitors and artifacts needs to be considered in the Virtual Museum. Thus, the addition of elements of storytelling is the next step so that visitors can associate historical artifacts with their lives<sup>20,21</sup>.

In addition, studies to improve the interactive interface with the digital world of 3-dimensional (3D) is still limited<sup>18,22,23</sup>. In the Virtual Museum, an interface is an important element to be considered because it is the intermediary of two entities, where computers and humans interact. A factor such as the user interface is complex, response times that are slow and limited live interaction such as simple enlarging and rotating objects found in most web-based system in formatted visualization of 3-D has been identified<sup>24</sup> and constraints provide interaction between humans and computers as a similar process with human interaction and human, and this aspect of change is difficult and expensive<sup>15,25</sup>. This difficulty has led to visitors not getting an effective and usable response from the user experience<sup>26</sup>.

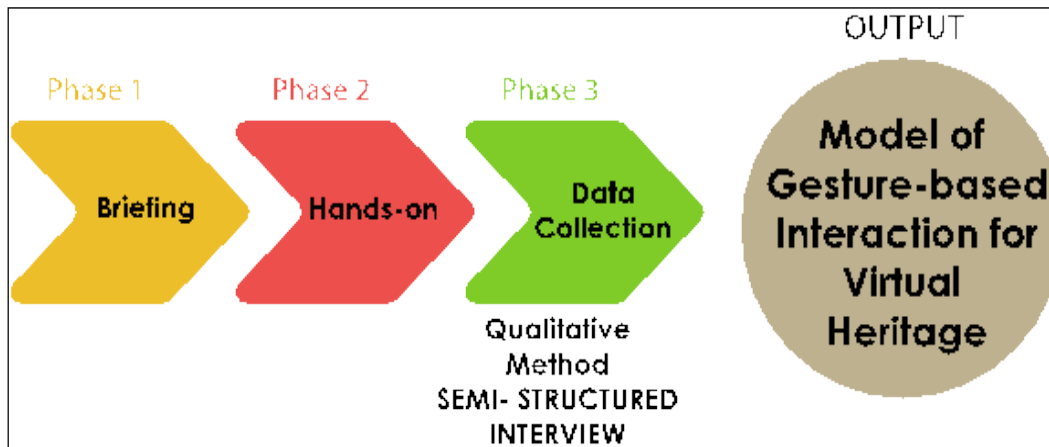
One of the critical aspects of the museum's visitors is still having trouble managing common input devices to interact with the virtual artifact in a 3D space such as mouse, joystick, keyboard, and console interfaces that are not natural; the period of time required for them to use the devices has generated unease. Traditional devices input-based paradigm WIMP to 35 years<sup>19,20</sup>, have constraints in providing interaction between humans and computers as a similar process with human interaction with humans and changes in this aspect is quite difficult and expensive<sup>12</sup>.

Most research in HCI that has been produced by researcher is more focused on aspects of usefulness and usability but does not take into account aspects of the user experience. User Experience (UX) is engaging user interfaces that interact with the system or any application where the user experience is related to the interest and can be evaluated<sup>27</sup>. In Line with the development of emerging technologies, researchers should be more focused on the aspects of the user experience, and the UX matrix is an important part of the process design and development to produce a technology that is efficient and easy to use<sup>27</sup>.

To date, progress on the development and design of the Virtual Museum has rapidly progressed through the involvement of users are not given special attention as no activity that can stimulate the knowledge of visitors, metaphorical storytelling, and emotional impact. In the Virtual Museum, aspects of the user experience and the use of technology is a challenge in developing a museum in a digital format. Virtual Museums need to focus on user experience rather than technology<sup>28</sup>. Even so, without the user's experience of technology, it cannot be achieved. So, both of these aspects need to be considered in the investigation of the Virtual Museum. Many researchers say that the user wants to interact with an interactive museum and be able to have a sense of fun. Users do not want to feel tired during the interaction, they need a process of natural interaction which allow users to search for information and can affect social aspects<sup>29</sup>.

### 3. Method

This study method is conducted to analyze the user interaction issues that have been stated by other authors from the literature review in the virtual heritage domain. The method is incorporate 3 phases include briefing, hands-



**Figure 1.** Method for design and development of a model.

on and data collection. Figure 1 show the methodology involved in this study.

### 3.1 Phase 1: Briefing

A brief description was given to the informant regarding the tasks they have to carry out. The procedures were designed to perform a study at the Department of Museums Malaysia (JMM). The first procedure is, the informant needs to browse the website of Virtual Museum of the Terengganu State through the following link [www.muziummaya.terengganu.gov.my](http://www.muziummaya.terengganu.gov.my) within 5 to 10 minutes. Then, after visiting the website, the informant was interviewed by the researcher with an average of 30 minutes for each informant. Interview questions were prepared by the researcher and given to the informant earlier on so that information required by the researchers can be delivered precisely by the informant.

The procedure was conducted as follows

1. Informant needs to browse the website of Virtual Museum Terengganu through this link [www.muziummaya.terengganu.gov.my](http://www.muziummaya.terengganu.gov.my) within 5 to 10 minutes;

2. After browsing the website, the informant was interviewed by the researcher with an average time of 30 minutes for each informant;
3. The question of the interview was prepared by the researcher.

### 3.2 Phase 2: Hands-on

In the time given between 5 to 10 minutes, informants browsed the Virtual Museum Terengganu website by navigating all the menu buttons & hotspots, exploring the museum environment through the panorama controller using the mouse and keyboard, manipulating the 3D object of the museum artefacts and searching through all the components of the museum's environment and artefacts.

### 3.3 Phase 3: Data Collection

A study was conducted using a qualitative method by using interview techniques with the informants. In this study, 10 respondents participated in this study consisting of experts, ethnic, non-ethnic and civilians. For the expert category, researchers have identified the director

**Table 1.** Identified issues based on theme included Story Telling (ST), User Interface (UI) and User Experience (UX)

| Issues   | Author           | Theme |    |    |
|--|------------------|-------|----|----|
|  |                  | ST    | UI | UX |
| Presenting important information is neglect.   | [30], [15]       | X     |    |    |
| Interactive visualization alone is not enough, need to be added the elements of storytelling and knowledge.  | [18], [19], [20] | X     |    |    |
| The digital cataloging of artifacts on the changes of scientific content in order to have a meaningful story was neglected.                        | [31], [20]       | X     |    |    |
| The storytelling in cultural heritage is still weak.   | [33]             | X     |    |    |
| The storyline is still unclear.  | [20]             | X     |    |    |
| Interface study to improve interaction with the 3D world is still limited.   | [18], [22]       |       | X  |    |
| The user interface is too complex.   | [24]             |       | X  |    |
| Response time is slow causing uncomfortable.   | [24], [26]       |       | X  |    |
| Limitations in doing simple interaction techniques.  | [24], [15], [25] |       | X  |    |
| Museum visitors still have problems managing common input devices to interact with virtual artifacts in 3D space.                                  | [15]             |       | X  |    |
| Music, sound and camera movement are considered unimportant.   | [25]             |       | X  |    |
| The effect of user experience is not given special attention.  | [28]             |       |    | X  |
| It does not take into account the public's attention and involvement, which is no activity of visitors, narrative metaphors and emotional effects. | [28], [7]        |       |    | X  |
| Aesthetic and natural experience is still inadequate.  | [29]             |       |    | X  |

of a museum and a museum curator. Meanwhile, for the ethnic category, they are Malays. Chinese and Indians are in the category of non-ethnic and foreigners from other countries are in the category of civilians that have no knowledge about the Malay culture. Interview questions are divided into two parts.

## 4. Analysis and Results

In this section, the results and findings were presented in the theme of issues, including Story Telling (ST), User Interface (UI) and User Experience (UX). Through the literature review, the user interface is complex, slow in response times, contains constraints in managing devices, and elements of music, sound and camera movement have been ignored and considered unimportant. The issues identified are in line with the findings of earlier surveys by researchers through a semi-structured interview technique using qualitative methods.

Based on the responses of respondents 1, 5, 7 and 10, it shows that museum visitors need a simple and intuitive interaction rather than complex interactions that would cause the response time of the system to become slow. This shows that with the implementation of natural user interface, the system can provide an application that allows users to control and manipulate the virtual environment. Table 1 showed the list of problems identified from the literature review based on categories of the themes.

The fact that user interfaces are complex, has a slow response time, and has constraints to manage devices and elements of music, sound, and camera movements makes for it to be categorized into the themes of User Interface (UI). UI theme in this research is a major issue that was identified. Based on the paradigm of UI, the latest paradigm is Natural User Interface (NUI) which is able to provide a simple and intuitive interaction. When

the interaction between people and systems is easy, it can improve the efficiency of the response time for the user. In addition, with the implementation of the NUI, users no longer have difficulties in terms of managing devices because Gesture-Based Interaction (GBI) can provide users the convenience of interacting using only body signals without the use of additional devices.

Besides the UI, Story Telling (ST) is also the theme of issues identified through the literature review. This can prove by the respondent 1 and 10 that preferred using storytelling technique in presenting the information. Most virtual heritage concepts quickly convey only information and functions the same as a digital library where the information displayed is brief information only. Moreover, most of them ignore the knowledge that does not reflect changes in scientific content in virtual heritage. Presentation of information which gives important points has been overlooked. The implementation of ST can be used as a method of information delivery. Although ST has been implemented in several researches, it still does not have a clear storyline and has a weak narrative in cultural heritage. Without a clear format for ST, it still cannot help increase the amount knowledge of the content of cultural heritage.

The theme of User Experience (UX) is also an issue that has been identified through literature review and votes early. To meet the needs of users, an application should be evaluated more on the UX aspects. Assessment of the UX can provide real emotional impact from the users with the adopted system. Based on literature review, attention and involvement of the users are not taken into account when designing and developing a system, even metaphorical storytelling aesthetic experience and naturally also still not enough. Therefore, the effect of positive emotions cannot be felt by visitors, in turn they cannot



experience the natural interaction like the interaction of humans with humans.

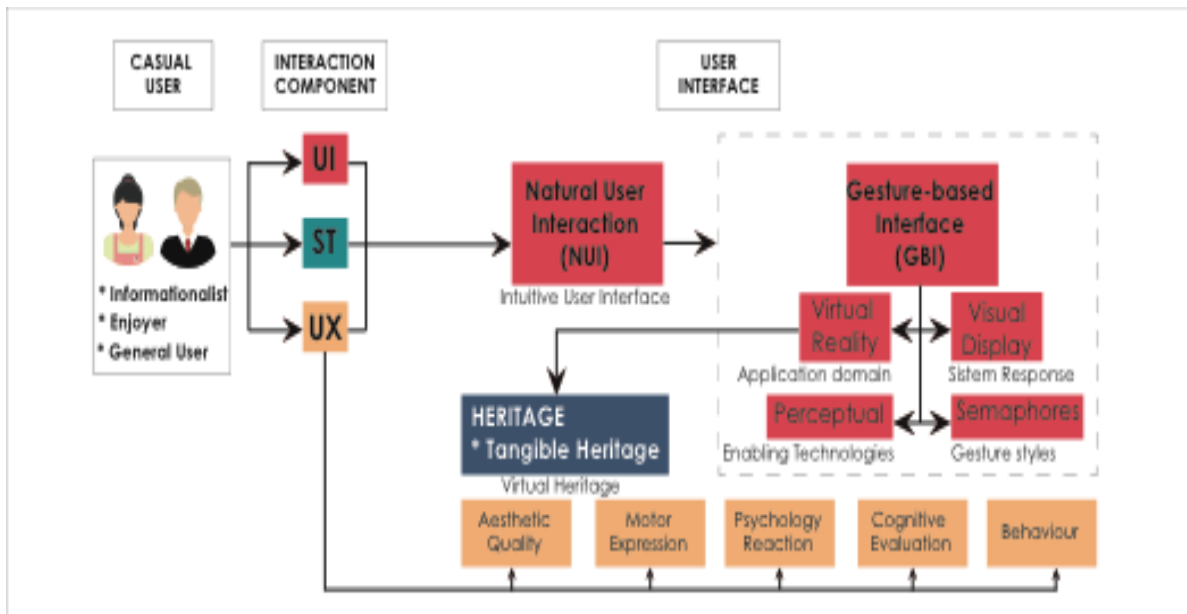
### 4.1 Initial Model of Gestures based Interaction for Virtual Heritage

This model involves the scope of the casual user which comprises of user categories including information list, enjoyer and general user. Casual users are users who are interested in getting information or enhancing their knowledge, it is interest-based intrinsic motivation. So, the casual user is identified in detail to the actual user requirements specifications issued to virtual heritage.

The components involved in the models that were produced are GBI and ST. GBI is one of the natural interaction techniques inherent in the NUI. This technique does not require an additional device by the user to interact with the system, users only use body gestures

to control, manipulate and track objects and environments in a simulated virtual environment. In addition to the GBI interaction techniques, ST has also dealt with the elements intended to enhance understanding and knowledge of any artifacts, historic sites and other components of the cultural heritage. ST approach is adopted in presenting and displaying information to the user.

To ensure that users can reach the level of actual experience, UX components are included in the assessment phase. UX identified three aspects in the perception of the quality of the instruments which are the usability and usefulness of the system, the perception of quality rather than the instrument itself that plays the role of the look and feel of the system and the user’s emotional reaction. Therefore, these aspects will affect the overall evaluation system that could affect a user’s decisions and behavior. The results of this study are the model of gesture-based



**Figure 2.** Model of gesture-based interaction through natural interaction and user experience for virtual heritage.

interaction through NUI and user experience for Virtual Heritage is shown in Figure 2.

## 5. Discussion and Conclusion

The issue of the user interface design of virtual heritage is a major issue identified from a literature survey and preliminary review by researchers. Through the initial survey, almost all respondents pointed out that the aspect of user interface design of the virtual heritage as one of the issues in virtual heritage and is also still in the experimental phase. One of the problems is the implementation of the user interface concept that still relies on regular inputs such as a keyboard and mouse that are only based on the WIMP. This causes slow reaction times and does not affect the user in terms of maintaining a long period of interaction time between the user and the system. Based on our preliminary review that was conducted by the researchers, the majority of respondents confirmed that the user interface implemented by most researchers is complex, and that consumers needed additional devices such as a mouse, keyboard, joystick and the like to interact with the application which causes users to feel disappointed.

In addition, more than half of the respondents agreed users still have to manage the device constraints. Furthermore, all of the respondents said they require easy interaction. Almost all of respondents agreed that audio elements such as background noise, background music and sound effects and the effects of camera movement was considered unimportant and was not implemented in a virtual inheritance by earlier surveys that have been conducted.

The results of the survey revealed that all respondents agreed on the concept of virtual heritage digitization of the catalog by simply storing data and information alone. Since the implementation of the concept of digitization artifacts cataloged, this does not prove the elements of a

comprehensive knowledge focused on the digitization of heritage artifacts cloud with approval by all the respondents.

Apart from the implementation of the concept of a catalog and scientific content, the method also displays artifacts. It cannot be only concerned with interactivity but there needs to be an element of storytelling where knowledge of the artifacts can be obtained by the user. Through the survey, almost all respondents agreed on the method of displaying artifacts that only focuses on interactive visualization only. Based on the survey, the majorities of respondents agree and express that the aspect of storytelling is one of the problems in virtual heritage where it is still weak and the storyline format is still unclear. No aspect of storytelling, appreciation, and knowledge of the artifacts can be realized due to still use the concept quickly and simply implementing interactive visualization only.

Because the design of the interface is complex and not intuitive, there is no element of storytelling to give appreciation and knowledge of the artifact to the user, therefore, the user experience cannot be achieved. Through literature research, aspects of the user experience also lack in focus and was not given special attention and this can be verified through this study that have been conducted with the approval of nearly all of the respondents. Through initial survey by the researchers, all of the respondents pointed out that in terms of the utility of the existing functionality in the system, it cannot stimulate the knowledge of the user, while the user is difficult to control the percentage of respondents learned were hundred percent. In addition, the majority of respondents indicated that the time required while using the system is less efficient and all of the respondents pointed out that the experience after using the system still cannot give the impression of positive emotions.



In conclusion, three research challenges in virtual heritage include a combination of narrative and format, the implementation of new interaction on the user interface and the emotional impact of the user experience.

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