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Design and Development of Architectural Model Darul Ridzuan Museum

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***Abstract*—This paper focuses on the 3D reconstruction of the architectural design of Darul Ridzuan Museum. It has concentrated on designing exterior part of the building according to colored digital photo of the real museum. Besides viewing the architecture, walkthroughs are generated for the user to control it in an easier way. User can travel through the museum to get the feel of the environment and to explore the design of the museum as a whole; both exterior and interior. The result has shown positive result in terms of realism, navigation, collision detection, suitability, usability and user's acceptance. In brief, the 3D virtual museum has provided an alternative to present a real museum.**

***Index Terms*—Virtual Heritage, 3D Modelling, Virtual Museum, Usability Evaluation**

I. Introduction

Cultural heritage is becoming an important application for virtual reality technology. Nowadays, when people want to see a museum, they need to visit the museum. Unfortunately, not all people are interested in visiting museum. People that usually go there are only school children and researchers who want to do some research on artifacts exhibited in the museum. Hence, virtual reality technology is needed to create virtual heritage model which represents the museum that will be easily viewed by all via Internet without going to the real museum.

The main focus of this study is, to design and develop architectural model of Darul Ridzuan Museum. The aim is to preserve cultural heritage building. This study will concentrate on designing exterior part of the building according to colored digital photo of the museum. This virtual heritage reconstruction will be able to display architecture and artifacts as the real one.

II. Related Work

Virtual heritage (VH) is the use of electronic media to recreate, or interpret, culture and cultural artifacts as what they are today or as what they might have been in the past. VH applications employ some kind of three dimensional representations and the means used to display it range from still photos to immersive virtual reality [1]. This is a very active area of research and development and most of it is intended for some kind of educational use.

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Virtual heritage applications use the immersive and interactive qualities of VR to give students or museum visitors access to computer reconstructions of historical sites that would normally be inaccessible, due to location or fragile condition. They also provide the possibility of visiting places that are no longer exist at all, or of viewing how the places would have appeared at different times in history [2]. One of the most well known high quality virtual reconstructions and architectural walkthroughs is, the one created for the Virtual Notre Dame Project, from Digital Studios [3].

Similar to Virtual Notre Dame project, another work is the Siena Cathedral simulation[4] , in which it was an immersive virtual environment. It allowed visitors to actually explore the site besides to experience its architecture and to obtain information on its architecture, culture and history. Moreover, it also allowed them acquire architectural, cultural, and historical information. A virtual guide, in traditional clothes, talks to the visitor by giving explanations about the Cathedral. The presentation is done in real-time using a stereoscopic large-screen projection. In order to achieve a high degree of immersion, the visual representation is complemented by sounds and background music [5].

A virtual museum is a collection of electronic artifacts and information resources-virtually, anything which can be digitized. The collection may include paintings, drawings, photographs, diagrams, graphs, recordings, video segments, newspaper articles, transcript of interviews, numerical databases and a host of other items which may be saved in the virtual museum's file server. It may also offer pointers to great resources around the world relevant to the museum's main focus [6].

There are many sites with representative samples of pieces from the collection of real physical museums, as well as sites which archive various pieces of real art as a museum collection, however, do not correspond to any real, physical location or collection. There are also sites which host collection of work by one artist, and sites which display only a particular exhibit from a real collection as well as some combination of these types. Moreover, less traditional and perhaps more interesting sites combine elements of multimedia to create interactive electronic exhibits, contradict to those exhibit in a real museum. There are also some sites, which are billing themselves a museum, which do not actually bear any resemblance to what we know as a museum. [7] have highlighted several advantages of virtual museum, which are:

- Timeless environment.
  The virtual museum provides visitor a timeless environment. It means that visitor can take their own time to explore the museum. Normally, museums are operated

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based on time. Therefore, some visitors may not be able to explore more and they have to come repeatedly.

- Keep the maintenance process of the items at the minimum level.
  With the development of virtual museum, the items need to be in digital format and stored in the server or hardisk. This will reduce the maintenance time, place and process. The exhibitor only has to maintain the stored data.
- Promote the actual/ physical museum inside and outside the country.
  Realize or not, the virtual museum can cooperate with the physical museum in order to promote the real museum inside or outside of the country.
- Reduce time and cost.
  The development of virtual museum will reduce cost and time. It is because with the building of virtual museum, the exhibitor does not have to find a suitable place to build a museum.

III. Design and Development

Modeling is done based on museum's digital-photos. 3D Studio Max 5 is used to model the object and the surrounding environment. 3D Studio MAX 5 software package is chosen due to its flexibility in polygonal mesh editing, and for its features regarding VRML exporting capabilities. Basically, the museum is built part by part, starting from the walls, to the roofs until the surrounding environments. The modeling of the museum is conducted for the interior and the exterior of the building. For the 3D architectural point of view Polygonal modeling techniques are mainly used in order to achieve:

1) The best trade-off ratio between the precision of the 3D representation of the model.
2) The maximum amount of displayable polygons for a real time platform at an acceptable frame rate.



Figure 1. Main entrance of Darul Ridzuan Museum

Figure 1 shows the original image of Darul Ridzuan Museum. Modeling was done based on the original images of Darul Ridzuan Museum, which was taken using digital camera. Every angle of the building was shot to help designers design the building appropriately.

Figure 2 shows the development of the museum, starts by creating the wall. Then by using box, most of the complicated object design starts with standard primitives shape such as box,

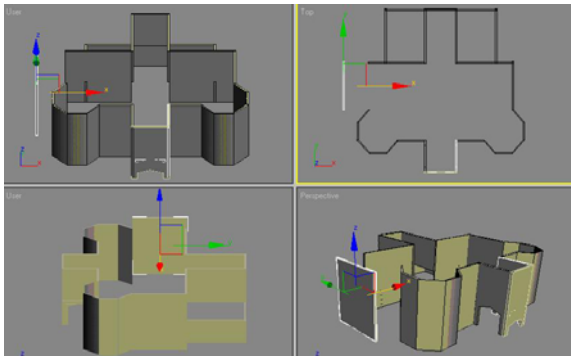


Figure 2. Development of the wall part by part.

sphere, cylinder, and so on. Wall is developed block by block which means wall is modeled as several separated boxes and will be joined together to create the wall of the museum. The main reason of creating the wall part by part is to ease the creation of internal design later.

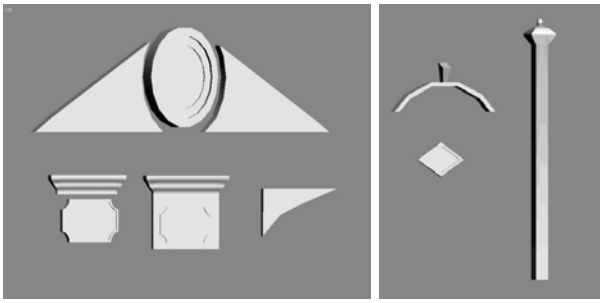


Figure 3. Create the artistic features

Once modeling of the main building, the next task is more complicated and time consuming which is, the modeling of Artistic Features of the detail structure design as shown in Figure 3. These objects were developed using several operations and techniques which is available such as Boolean Operation, Edit Mesh technique, Extrusion concept and Clone concept.



Figure 4. Front view of museum

Figure 4 shows the front view of the museum. It is a 2D image view which is perceived to have x and y axis. From this view, user can only see the width and height of the museum. Besides that, it is the initial view when the user starts their navigation.

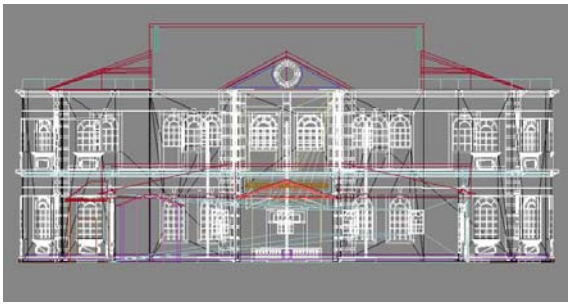


Figure 5. Wireframe view of museum

Figure 5 shows the wireframe view of the museum. It displays the museum as a polygonal mesh (lines that make it look as though the objects are made from a wire screen mesh). Besides that, this view also displays the actual polygons comprising the museum including the polygons that would normally be hidden from view.

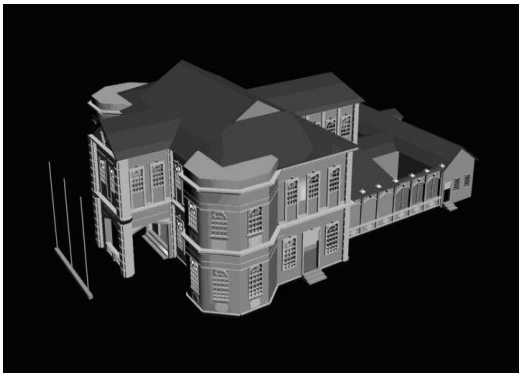


Figure 6. 3D view of museum

Figure 6 shows the 3D view of the museum. It is a 3D image view which perceived as to have x, y and z axis. From this view, user can see the overall look of the museum such as the width, height and depth of the museum.

IV. Evaluation

Data is gathered through the evaluation phase. In the evaluation phase, there are 30 sample users being called to view and navigate the virtual museum developed. 30 respondents are called one by one to view and try out the application itself. From their experience on the virtual museum, the user is required to answer a set of questionnaires regarding the application.

The types of questions used for this project is multiple choice questions which means there are several alternatives for them to choose. The considered scopes in the questionnaires are realism, navigation, collision detection, usability of application, suitability of application, and user acceptance. The purpose of this formation of questionnaires is to get user feedback on the virtual museum, which is being developed.

Figure 7 shows the result obtained from the survey handed to 30 sample users, which show the percentages of respondents giving grades to realism aspect. A scale of 4 and 5 are

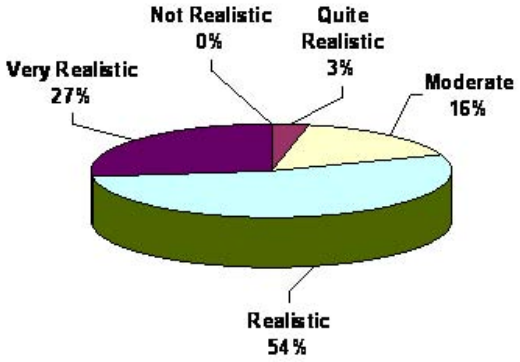


Figure 7. Realism of the Virtual Museum

considered as good respond from users. It shows that the percentage of users responded to the scale of 4 and 5 are 54% and 27%. The percentage of user responded a moderate scale of 3 is 16%. Meanwhile, 0% and 2% of users responded to a low scale of 1 and 2. The highest percentages in realism indicates that the overall virtual museum looks realistic.



Figure 8. Navigation Aspect of the Virtual Museum.

Figure 8 shows the percentages of respondents giving grades to navigation aspect. A total of 63% and 11% have responded to a scale of 4 or 5. They all agreed that navigation is easy and very easy. Apart from that, 0% and 2% have responded a low scale of 1 or 2, rated as hard or quite hard. The highest percentage is easy level and the second highest is moderate level. This indicates that this application is easy to be explored.

Figure 9 shows the percentages of respondents giving grades to collision detection aspect. A total of 54% and 22% of those responded to a scale of 4 or 5 as effective or very effective. Apart from that, 24% voted to a scale of 4 which is moderate level and 0% or 3% those responded to a low scale of 1 or 2, which is rated as not effective or quite effective. The percentage for this aspect is higher with a total of 76% of users agreed that collision detection is important, and that it is well-applied in this application.

Figure 10 represents the respond from the user towards the suitability of the application. The objective of this question is to know whether the application developed is suitable to be used as an alternative way for promoting museum instead

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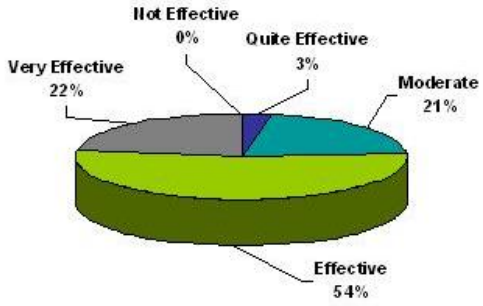


Figure 9. Collision Detection Aspect of the Virtual Museum.

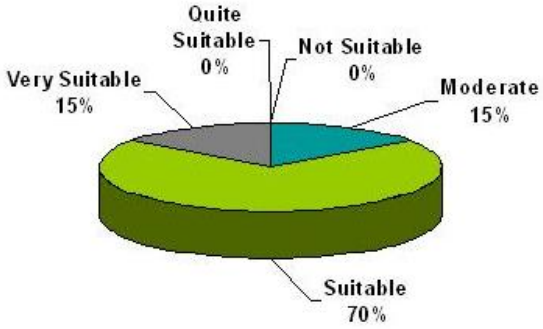


Figure 10. Virtual Museum Suitability

of the real museum. A scale of 4 and 5 considered a great respond from the users. It shows that the percentage of users responded to scale of 4 and 5 are 70% and 15%, who agreed to use this application as an alternative way. The percentage of user responded a moderate level is 15%. Meanwhile, no users responded a low scale of 1 and 2. The highest percentage is a suitable level. This means that the application is suitable as an alternative to the real museum.



Figure 11. Virtual Museum Usability.

Figure 11 represents the respond from the user towards the usability of application. A scale of 4 is considered as great respond from users. It shows that the percentage of responded scale of 4 is 75%. The percentage of user responded to a moderate scale of 3 is 13%. Meanwhile, 0% and 0% of users responded a low scale of 1 and 2. The highest percentage is a useful level. This means that the application is useful to people because they can view the museum and its collection from their desktop. It also indicates that the users have agreed with the significant of virtual heritage application being applied for developing museum.

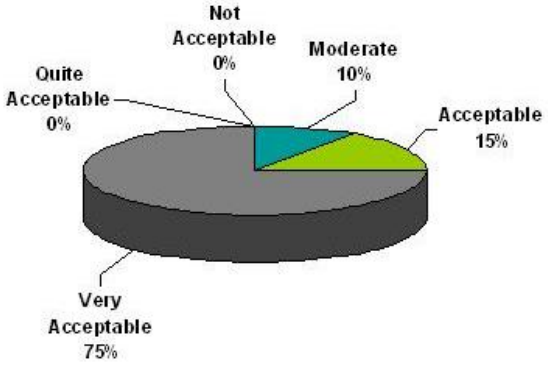


Figure 12. User Acceptance

Figure 12 represents the user's acceptance towards the application. A scale of 4 and 5 are considered as great respond from users. The pie chart shows that the percentage of users responded to the scale of 4 and 5 are 75% and 15%. The percentage of users responded to a moderate scale of 3 is 10%. Meanwhile, no users responded to a low scale of 1 and 2. The highest percentage is an acceptable level. This indicates that the users have agreed to accept the existence of this kind of application.

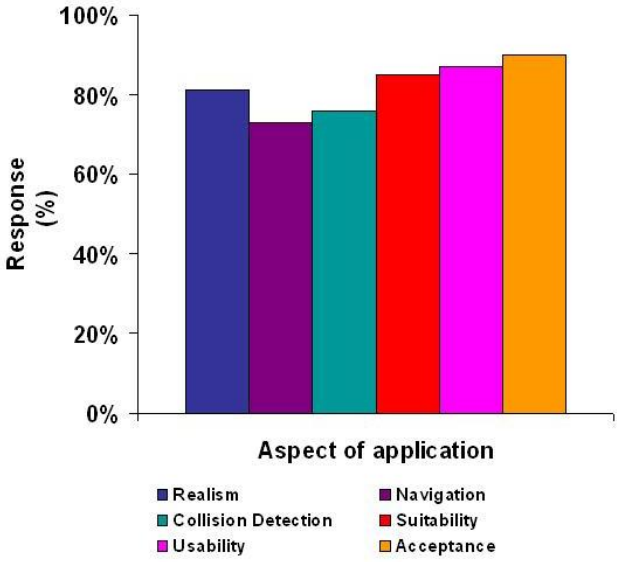


Figure 13. Evaluation Summary

Figure 13 shows the summary of evaluation result for all the aspects tested on user. The main aim of the survey is

to eamine each aspect of the application. From there, the improvement can be made based on the responds. The x-axis represents the aspect of application evaluated while the y-axis represents the percentage of response. According to the diagram the highest value is User Acceptance with the percentage of 90%. This shows that the application is highly accepted by users. Followed is the second highest value of percentage that is Application Usability with the percentage of 87%. This indicates that the application is useful to people because they can view the museum and its collection only from their desktop. Moreover it is useful because there is no such virtual museum application in Malaysia. While the third highest of percentage value is Application Suitability with the percentage of 85%. This indicates that this application is suitable to be used to promote museum as an alternative instead of the real museum. For the realism of virtual museum, the users have rated 81%. Realism is an important aspect to consider. This percentage can be increased more by doing some improvements on the virtual museum model in order to increase the realism. Next for the collision detection, most of the users gave a percentage of 76%. This indicates that they agreed that collision detection is a main factor to be considered when developing a virtual environment to get the feeling of immersion.

V. Conclusion

This virtual museum acts as an alternative to present the real museum. Parallel to the current technology it has enables Darul Ridzuan Museum to be preserved virtually. Moreover this virtual museum will attract the user's attention to explore the museum. Finally as a future enhancement, to increase the level of realism to the virtual environment, animation can be included. Animations in this case can be in the form of virtual human walking around the museum. A virtual agent guiding the user for a walkthrough around the museum, as the users are able to follow the virtual agent and not getting lost. This will make this virtual museum more appealing to the eyes of the users.

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