Haptic (Touch) Museum

by

Nor Azureen binti Abdul Aziz

Dissertation report submitted in fulfilment of

the requirements for the

Bachelor of Technology (Hons)

(Information and Communication Technology)

JANUARY 2011

Universiti Teknologi PETRONAS

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the

Information Technology Programme

Universiti Teknologi PETRONAS

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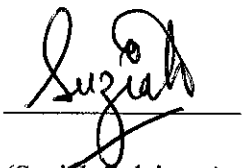
Approved by,



(Suziah Sulaiman)

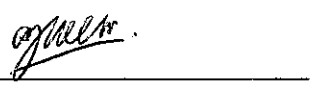
UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

January 2011

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgement, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.



NOR AZUREEN BINTI ABDUL AZIZ

ABSTRACT

State-of-the-art haptic (or force-feedback) devices allow users to feel and touch virtual objects with a high degree of realism. While, museum is an institution which protects and preserves the national heritage as well as delivers the knowledge to the general public. Haptic technology will provide touch experiences to wider audiences; allow users to use their sense of touch and will able to feel virtual materials as if they were touching a real physical specimen while preserving the artefacts for a longer period.

ACKNOWLEDGEMENT

First of all, I would like to express my utmost gratitude to Allah S.W.T for making it possible for me to complete my Final Year Project in Universiti Teknologi PETRONAS. I would also like to express my appreciation to my beloved family and friends for giving me such needed support.

My deepest gratitude goes to my supervisor, Dr Suziah Sulaiman, in making my Final Year Project a success. Dr Suziah has given me her support and advices since day one and also her countless learning opportunities throughout the period. She also plays a very vital role in supplying me with a clear picture and in clarifying me how the project must be managed and what is the final output.

Finally I would like to give appreciation to all my colleagues and friends who have contribute directly or indirectly throughout the frequently stressful period in which this final year project was carried out. After all, their brilliant suggestion and sincere review have greatly enhanced the my project.

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CHAPTER 1
INTRODUCTION

.1 Background

Museums are an institution to promote national history, culture and heritage. The international Councils of Museum, or ICOM in short, defines a museum as "a non-profit making, permanent institution in the service of society and of its development, and open to the public, which acquires, conserves, researches, communicates and exhibits, for purposes of study, education and enjoyment, material evidence of people and their environment". Basically the distinct role of museum is to safeguard and preserve the heritage of a nation or community.

New technologies from the area of virtual reality (VR) now allow computer users to use their sense of touch to feel virtual objects. Touch is a very powerful sense but it has so far been neglected in computing. Haptic technology devices allow people to use their sense of touch in computer-based application.

.2 Problem Statement

Museums house collections of art or artefacts but due to preservation, precious objects are placed behind glass in order to provide access to visitors and also maintain a safe distance and barrier from potential harm. Therefore, there will be limitation for visitors as the artefacts only offer visual modes of access. As touch plays an important role in the learning experience, a visual mode of access inhibits the total pleasure of museums experiences. Just looking at exhibit, even as 3D graphical models, is limiting. If allowed, most visitors would immediately pick up an object, feel its textures, feel its weight. An artefact's surface properties can be modelled so that someone using haptic device could feel it as a solid, three-dimensional object with different textures, hardness, or softness. By this, very fragile objects would be available for visitors who live far from museums to feel objects at a distance.

In conclusion, from this project, users will get to feel the virtual artefacts with different textures or weight. Also, one of the key reasons for using haptic technology in museums is

to improve the experience of objects and artefacts that visitors have. Haptic also allows the visual displays to be extended to make them more realistic, useful and engaging for visitor.

.3 Objectives and Scope of Study

1.3.1 Objectives

The objectives of this project are to:

- Investigate how haptic technology can benefit museums
- Develop a haptic prototype which allow users to use their sense of touch to feel the artefacts
- Evaluate the prototype in terms of user preference and satisfaction

1.3.2 Scope of Study

- This project focuses on museums
- The users of this application could be visitors to the museums, scholar, students, or visually impaired.

CHAPTER 2
LITERATURE REVIEW

.1 Haptic Feedback

Haptic technology refers to sensing and manipulating through the sense of touch. The word derives from the Greek language "haptesthai" which mean "to touch". The haptic technology provides a force feedback by applying different forces to the users about the physical properties and movements of virtual objects represented by a computer. Haptic technology enables the users to feel the texture and allow somebody to touch, feel, and stimulate in a virtual realm.

2 Haptic Device

Figure 1: Sensable Phantom Desktop Haptic Device

Haptic devices (or haptic interfaces) are mechanical devices that facilitate communication between the user and the computer. Haptic devices allow users to touch, feel and manipulate three-dimensional objects in virtual environments and tele-operated systems. Haptic devices are input-output devices, meaning that they track a user's physical manipulations (input) and provide realistic touch sensations coordinated with on-screen

events (output). From the devices, the pen will allow users get to feel the forces and navigate through the virtual objects on the computer.

3 The level of Information and Communication Technology Use by Museum in Malaysia

Information and Communication Technology (ICT) refers to the technology of acquiring, storing, processing, and disseminating information through the use of computer technology and telecommunication. Recent advances in ICT have definitely affected the way teaching and learning (T&L) is delivered in both formal and informal education. Besides education, ICT should be implemented elsewhere in related institution. For museums, it should obtain the benefits of ICT to help disseminate the knowledge to the general public.

Museums range from the historical monuments and sites to nature reserves, planetarium and aquaria. In Malaysia, museum institutions are governed by Department of Museums Malaysia (DMM) at the federal level under Ministry of Information, Communication and Culture.

The use of ICT is not merely for digitizing old photos and old documents, but also for object reconstruction and dissemination. It is found that all museums have installed adequate ICT infrastructure and provided basic ICT services and applications. Besides that, there is institution that has video conferencing facilities and an advanced ICT is having 3D laser scanning and virtual reality. For ICT in museum exhibitions, a popular technique for public display is diorama that uses a dummy with sound effects and narration; hologram whereby 3D computer images or videos are projected to sculpture or setup; sound and light system; and audio visual presentation. Besides that, touch screens are widely used as interactive user interfaced and not only that, a half dome system as well as car and flight simulators. Other than that, computer kiosks are widely installed for public display and also digital storytelling using hologram and multimedia presentation.

It can be concluded that the level of ICT use by museums is average. Nevertheless, the level of ICT use in museum exhibition halls is very low and not encouraging.

.4 Touch Feedback in Museums

Haptic technology provides the possibility of widening access to information and artefacts held in museum. The devices allow people to use their sense of touch and could feel textures and shapes of virtual objects, modulate and deform objects with a very high degree of realism. In brief, a haptic device provides position input like a mouse but also stimulates the sense of touch by applying output to the user in the form of forces.

Haptic technology is already being used in museums, but on a small scale in much specialised situations. One such example is the University of Southern California's Interactive Art Museum. The museums used the PHANToM device within the museum to allow visitors to feel artefacts. One of the key reasons for using haptic technology is to improve the experience of objects and artefacts that visitors have.

There are many advantages to have a haptic device for museum artefacts. One of the advantages are; Objects which are very fragile may not be handled by museum visitors and visual models can be created but there are many aspects of the object that this does not capture therefore objects could be haptically modelled and then visitors could feel them. Also, objects that are haptically modelled and then made available on a museum's website could be access by long distance visitors who are not able to visit the museum. Moreover, this technology can increase the number of artefacts on display because visitors could experience these on computers, without taking up museum space.

Now haptic technologies are available that let museums add this missing aspect back into their computer-based exhibits. They allow the visual displays to be extended to make them more realistic, useful and engaging for visitors.

2.4.1 PURE-FORM Project

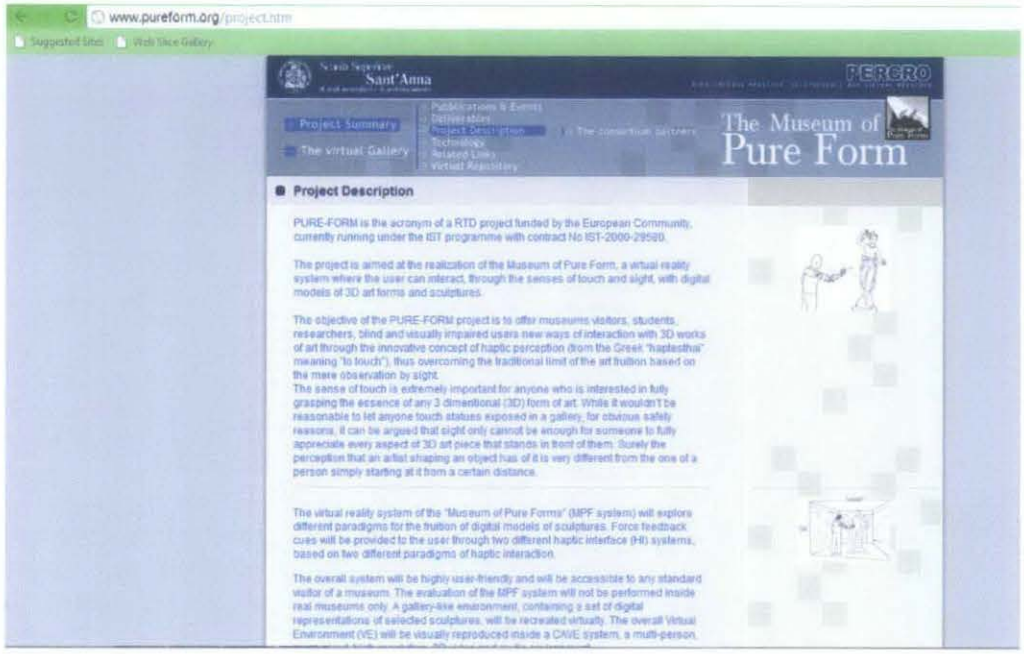


Figure 2: Webpage of The Museum of Pure Form

(http://www.pureform.org/project.htm)

The Museum of Pure Form is a 3-year funded project on the IST program of the European Union. The main concept is to allow visitors to touch virtual representations of artefacts presented in a museum. There are four museums which are partners in this project: Centro Gallego de Arte Contemporanea, Santiago de Compostela in Spain [cga], The National Museum, Stockholm in Sweden [nm], ThePetrie Museum, London in UK [pet], and the Museum of the Opera del Duomo, Pisa in Italy. All allowed artefacts from their museums to be scanned and presented to the public in The Museum of Pure Form.

The Museum of Pure Form is a complete system that includes graphics software, a display system, a haptic device and interface, and a virtual museum that contains representations of pieces of art.

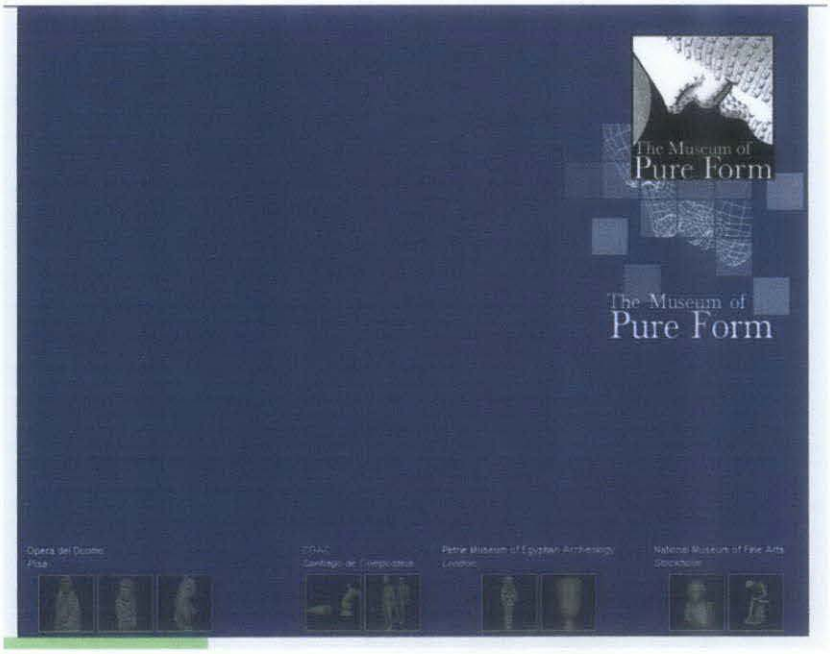


Figure 3: The virtual gallery of The Museum of PURE Form

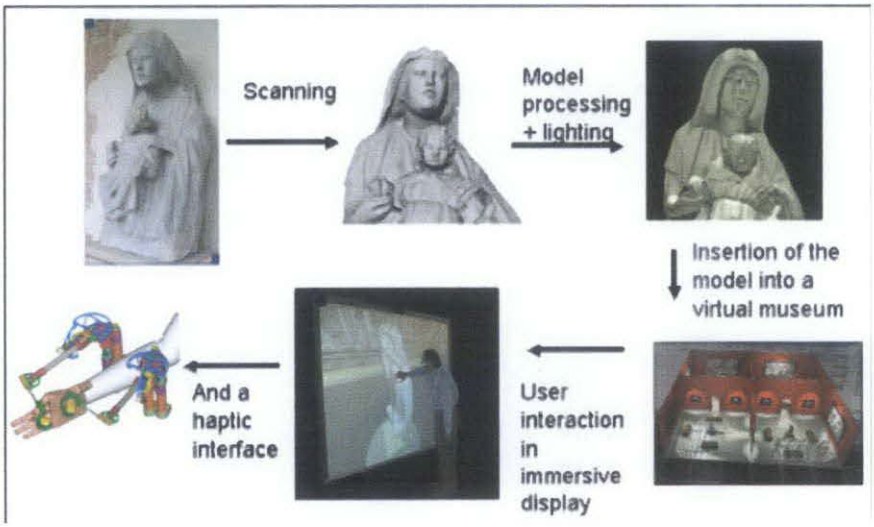


Figure 4: Overview of the different steps necessary to build the Museum of Pure Form

The first process of digitisation is deciding on the statues to scan. Statues were chosen on multiple criteria: the interest to the museums, the predicted interest to visitors, the availability of the statue, and suitability for scanning. Several factors influence a statue's suitability for scanning. For a statue to be scanned, there must either be enough space surrounding the statue (in the physical

museum to which it belongs) that it can be scanned in the current museum where it is from or it must be transportable so that it can be scanned elsewhere. A statue's suitability for scanning is also influenced by its material. Acquisition of an accurate model requires that the material reflects the beam in the right direction, resulting in reduced geometrical inaccuracies. The shape also needs to be as continuous as possible since holes are more difficult to connect. After all the steps on choosing the statues, the statues will be scan by a company called 3D Scanners (3DSA) which is also the manufacturer of the scanner. When designing the virtual museum, the scanned artefacts will be placed at the centre of the room.

Figure 5 : Model of the Museum of Pure Form

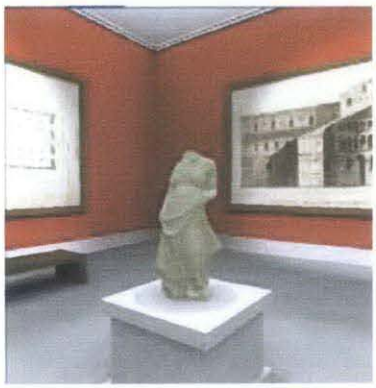


Figure 6: Example of a room of the museum with a statue displayed

2.4.2 The Palace Museum, Beijing

Figure 7: Website of The Palace Museum, Beijing (http://www.dpm.org.cn)

The museum is also known as the 'Purple' Forbidden City in Chinese, or the Forbidden City as it is commonly known in English. It covers 720,000 square meters and was the imperial palace for a succession of twenty-four emperors and their dynasties during the Ming and Qing periods of Chinese history. The museum is also China's largest and most complete architectural grouping of ancient halls. Construction was begun in 1420, the eighteenth year of Yongle, so that the site has existed for the past 580 years.

The collections of the Palace Museum are based on the Qing imperial collection. Today, there are over a million rare and valuable works of art that is being exhibit in the Palace Museum. The artefacts include paintings, pottery, inscribed wares, documents and others.

Besides the exhibitions in the Forbidden City itself, anyone could look through the Palace Museum website and find several artefacts that are being display on the website for anyone to view.

Figure 8: Main Page of The Palace Museum

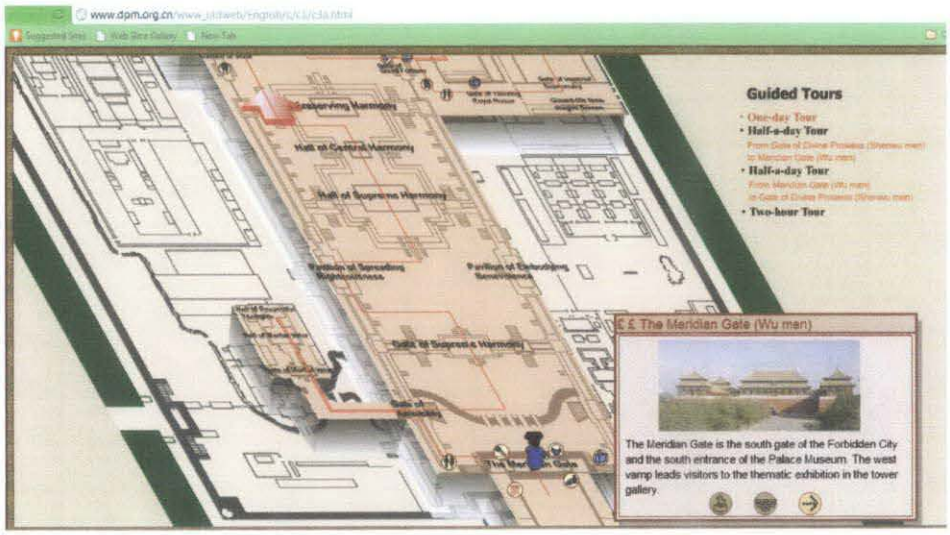
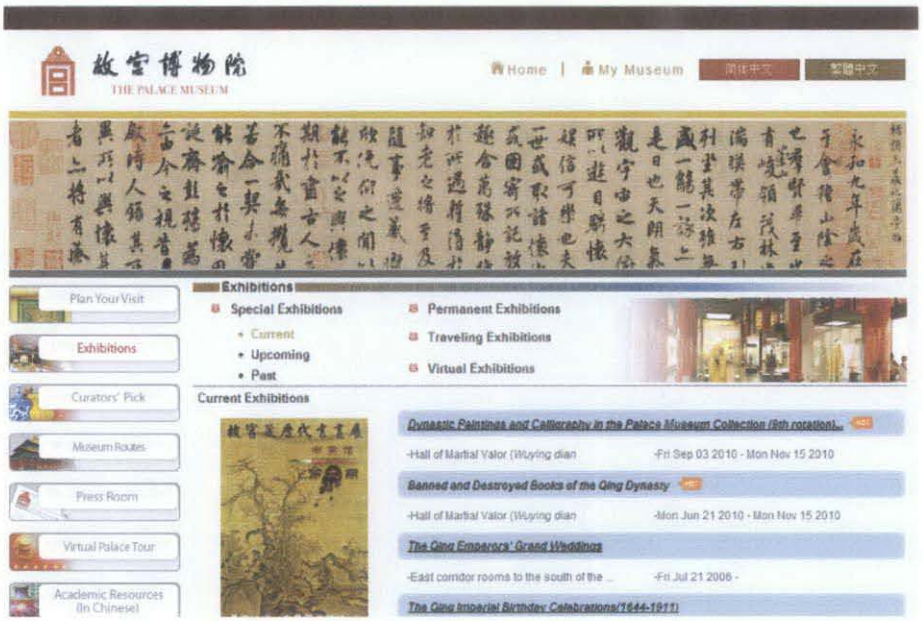


Figure 9: Virtual Tours for The Palace Museum

From Figure 8, users can choose to look at the exhibitions and even take virtual tour of the Palace Museum. Moreover, in Figure 9, it shows the virtual tour for The Palace Museum where the users are able to go to the different places in the museum and also a brief description of that particular place.

Additionally, the Figure 10 shows the different exhibition provided in the website for the users to choose from. It has special exhibition that is divided by current, upcoming and past. Also, there are permanent exhibition, travelling



exhibition and virtual exhibition.

Figure 10: Exhibition's Page

For a few examples of the artefacts, please refer to Appendix B, C and D. Besides the image of the artefacts, it has a brief description about that artefacts and other informations regarding that exhibit.

2.5 Museum Application

Based on the literature survey, the features examined from the museum applications could be summarised as shown in Table 1.

Without Haptic	With Haptic
Only concentrate on visual senses (e.g. Do Not Touch signage)	More senses can be used (Visual, Touch)
Need more space to exhibit the artefacts	Could save space because it is a computer-based applications
Due to preservation purpose, a lot of artefacts can only be look at	Allow rare, fragile or dangerous objects to be handled
Visitors need to go to the museum to look at the exhibitions	Allow long distance visitors.(via websites etc)

Table 1: Museums Comparison

Table 1 shows the difference museum application that has a haptic technology with the one without haptic technology. For example The PURE FORM museum provides more advantages as the museum has haptic capabilities and enables visitors to feel and touch the artefacts in 3D.

CHAPTER 3
METHODOLOGY

3.1 Project Methodology

The waterfall methodology was chosen for the project development of this project. The waterfall approach is a consecutive development approach where the development is seen as flowing downwards through each phases (analysis, design, implementation, testing, integration, and maintenance).

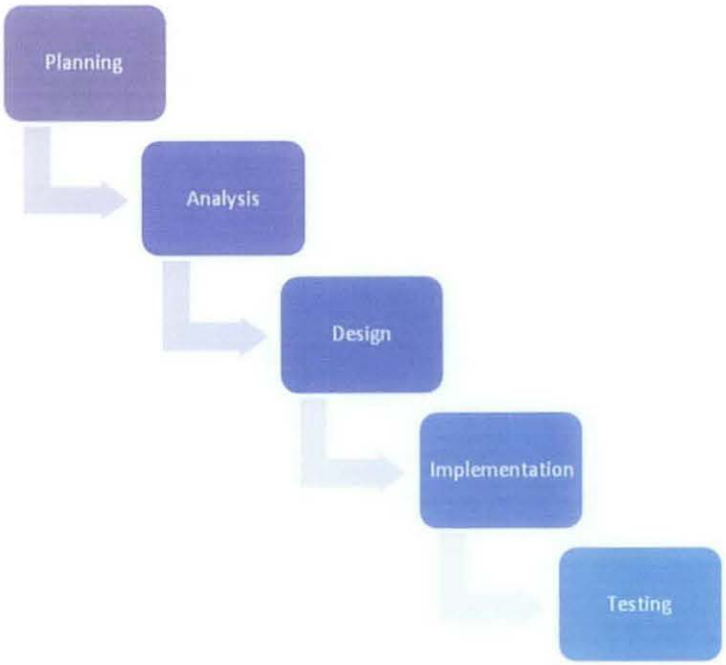


Figure 11: Project Methodology

3.1.1 Planning

The planning phase is the first phase of the project where it is the process of understanding the main reason why the system should be built as well as considers all the project requirements. Also, the value and purpose to the target user will be identified to gather more information. In the case, research on haptic technology and current touch museums around the world is crucial.

3.1.2 Analysis

Analysis phase is where it is important to view every aspect of the projects and briefly identify the features that will be implemented into the system. Not only that, each findings should be analysing to view whether the data are aligned with the systems.

3.1.3 Design

The design phase decides how the system will operate, in terms of hardware and software, the user interface and anything related to the project. In the design phase, the system architecture will be further discussed based on the system requirements.

Also, the steps to design the user interface will go through several phases before getting to the final interface.

3.1.4 Implementation

In implementation phase is where the prototype will be developed based on the deliverables such as the architecture design and interface design. The system will be built to fulfil the user requirements and accomplished the project purpose.

3.1.5 Testing

The testing phase is where when the system is done and it has to go through several steps, firstly to test the functions of the systems and how users used it. Moreover, error checking or bug checking for the system will happen at this stage.

3.2 Methods for Data Gathering

3.2.1 Research

For the project, research about other touch museums around the world is important. It is crucial to find out how touch in museum being developed and understand of how it works.

3.2.2 Interview

To gain more insight on the area of study, an interview will be conducted with a specialist in the area. The person would either be an expert about arts or artefacts in Malaysia or someone who managed and have experience in managing a museum. Open-ended questions will be used more to capture the experts experience and opinion.

3.3 Gantt Chart

See Appendix A

3.4 Tools

3.4.1 Software

1) OpenHaptics
   - The OpenHaptics toolkit enables software developers to add haptic feature.
2) HTML
   - Used HTML to create the interface for the application

3.4.2 Hardware

1) SensAblePHANToM

CHAPTER 4
RESULTS AND DISCUSSION

4.1. Museum Visited

1) Darul Ridzuan Museum

Situated in Ipoh, the museum was previously the official residence for Malay dignitaries in the Kinta District.

Figure 12: Darul Ridzuan Museum, Ipoh

Among the interesting artefacts there are the history and development of Ipoh and the mining of the forestry of Perak. It houses the historical remnants of the mining and forest industries of Perak. ١ from my observation, they have old equipment for mining, the different types of woods, and different insects in the forest etc. Due to the insignificant of the artefacts towards the project which is to stimulate the different kind of texture of fabric, I decided to find other museum for the purpose of this project.

4.2. Survey

The questionnaire created to gain more information regarding museums and haptic technology. From this questionnaire, I was able to get more insight on the level of knowledge the public has about haptic technology and also from this questionnaire; it helped me to decide the artifacts that I will be using for the application.

The survey was conducted in the analysis phase of this project where some of the task were creating the questionnaire, handing out the questionnaire to other people and in this case was given out to 20 people, analysis each answers and others.

Haptic (Touch) Museum

1) How often do you visit museums in a year?
   a) 1 or 2
   b) > 3

2) Have you ever heard about the touch technology?
   a. Yes
   b. No

3) If you could feel the artifacts in the museums, would you feel it?
   a. Yes
   b. No

4) What sorts of artifacts you wish to touch?
   a. Fabric/Textile
   b. Porcelain
   c. Coins
   d. Paintings
   e. Others:_____

5) Are you willing to go a museum that provides a touch technology for the artefacts?
   a. Yes
   b. No

Figure 13: Questionnaire

From the survey, the respondents are raging for the age 21 to 24 years old and all of them comprises of a group of students. Based on the survey, each question has been analysed and a clustered column chart have been chosen to represent the data.

Question 1

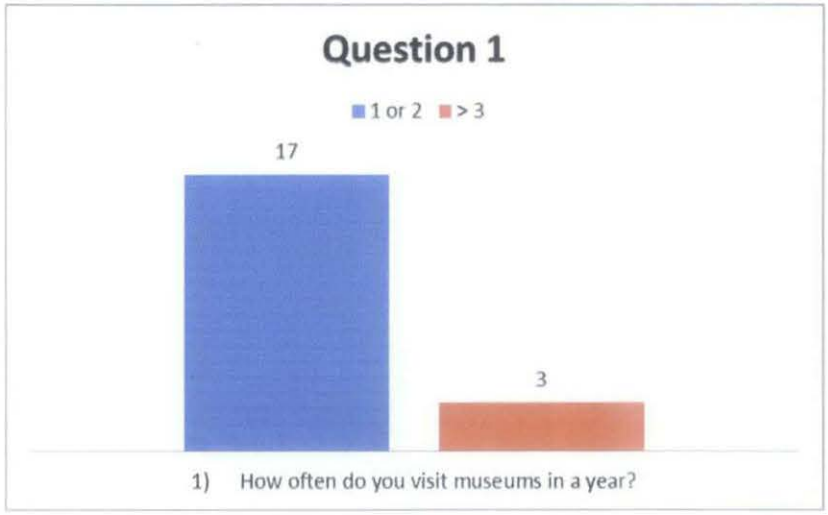


Figure 14 : Chart for question 1

The question 1 asked the respondent how often they visit museums in a year. The significant of this question is because it could show the importance of museums in their opinion and do people still visit museums in this modern world. Based on all of their answers, 17 people out of 20 people said they visit museum in year is either 1 or 2 times while 3 people said they visit museum more than 3 times in a year

Question 2

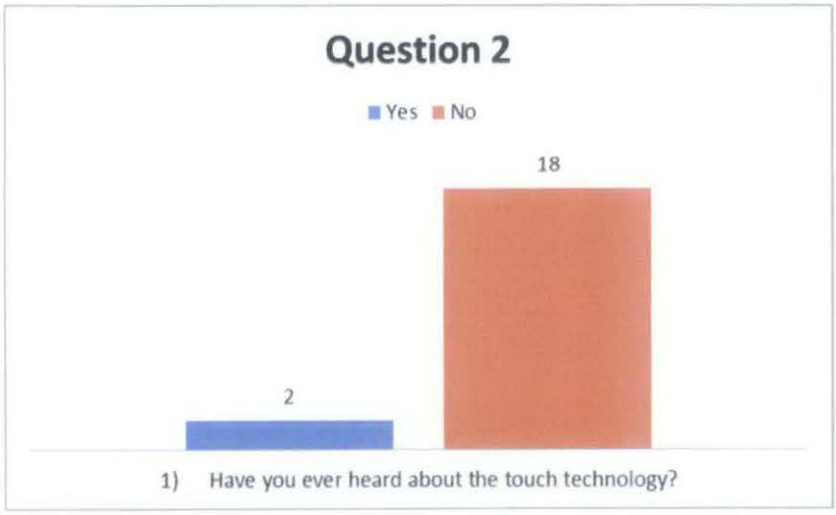


Figure 15 : Chart for Question 2

For question 2, the respondents were asked have you ever heard about the touch technology. Based on the survey where only 2 people said they knew about touch technology while 18 people do not know and have not heard about the touch technology. This shows that most people are not aware of the haptic technology that is available and the advantages of having haptic technology. This is most probably due to the high cost to adapt the haptic technology in an everyday devices and the public have not been expose to this kind of technology.

Question 3

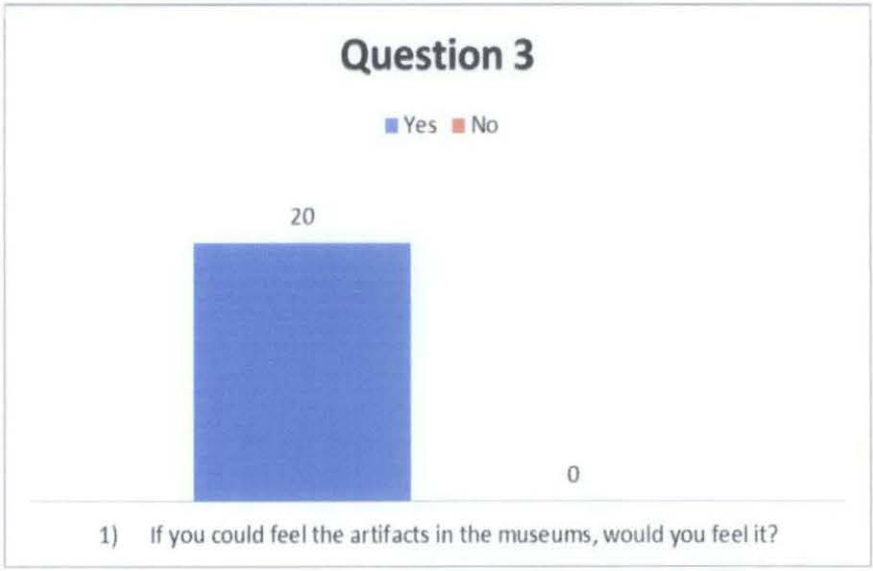


Figure 16: Chart for Question 3

The above diagram shows the results of question 3 where the people were asked whether they would feel the artifacts in the museums if they were given the opportunity. From that question, 20 people or 100% answered yes they would want to touch the artifacts in the museums if they were given the opportunity. This shows that anyone would want to touch and feel the texture and weight of the artifacts in the museums. One of the reasons is that touch is one of the important senses and people learn more by using their touch sense and they could have the full experience when visiting museums.

Question 4

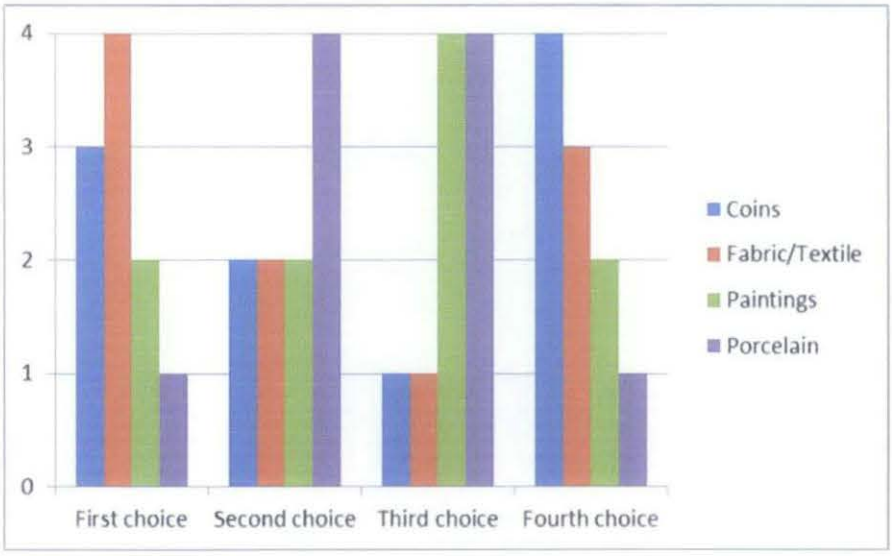


Figure 17: Chart for Question 4

For question 4, it could be considered as the most important question for this survey as it determines the features of the application. First of all, the artifacts were chosen because these artifacts are the common artifacts exhibit in museums. The scenario of this question is for example, if there are these 4 items, which one would they want to pick up and touch first therefore from the results, most people which are 4 people chose fabric/textile as the item that would pick up first and feel the texture. While the second item they would pick up next is porcelain and the third choice is a painting. Finally, the last item they would want to feel is the coins.

Question 5

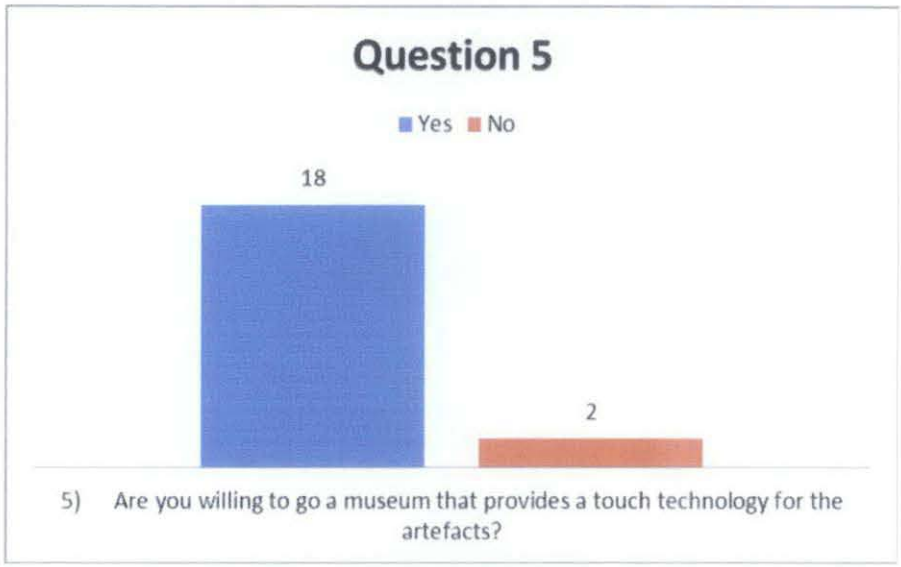


Figure 18: Chart for Question 5

The final question for the survey is you willingness to go to a museum that provides a touch technology for the artefacts. From this question, 18 people said yes to their willingness to go to a museum that provides haptic technology while only 2 people said no. From this question, it shows that people are willing enough to go to museums and use the touch technology to touch and feel the artifacts.

4.3. Fabric Chosen

After data gathering and analysis, the artifacts that will be used are fabric/textile. While the type of fabric/textile that will be used are silk and "songket". The reason why these fabrics have been chosen because of the different texture where silk has a soft texture while the "songket" is more hard and rough. Also, "songket" is one of the traditional kinds of fabric in Malaysia and in most museums around Malaysia that exhibit an old malay attire, usually the attire is made out of "songket" especially the royalties' attires.

Silk

"Songket"

4.4. System Flowchart

The flowchart shown in Figure 19 shows the flow of the whole system. The users will start at the system interface and on the interface will state the artefacts and in this case, there two artefacts to choose from. Either choose the first artefacts or the second one, the output will show the graphic of the artefacts with touch feedback capabilities. The user can go back to the main page and continue to view other artefacts and just end the system.

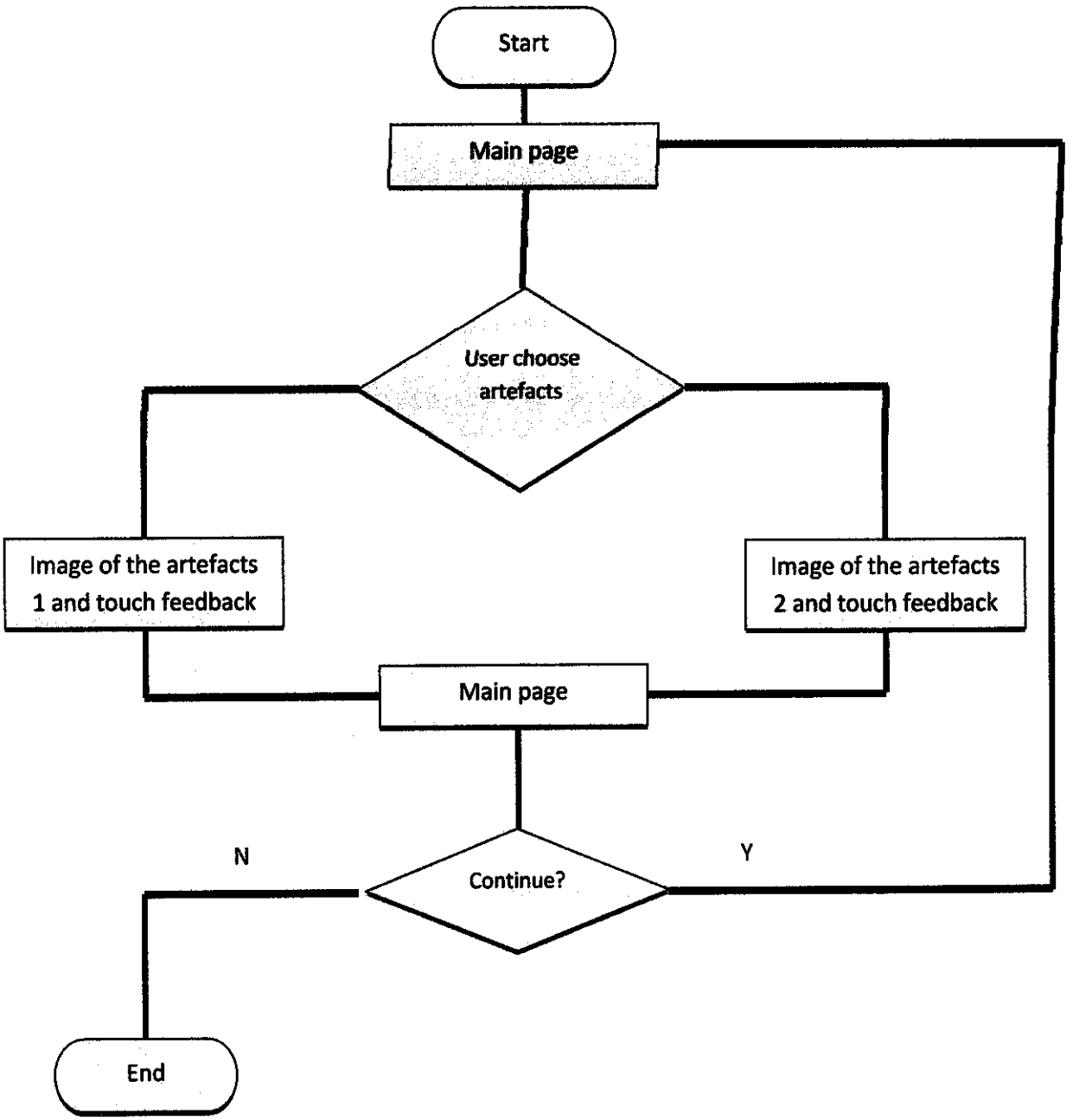


Figure 19: System Flowchart

4.5. System Architecture

The system architecture shows how the interactions between users, system and haptic device. The system will show a visual of the different artefacts to the users and the users will choose the artefacts. After the artefacts have been chosen, the system will show the haptic interface and the haptic device will be called to interact with the users to give touch feedback.

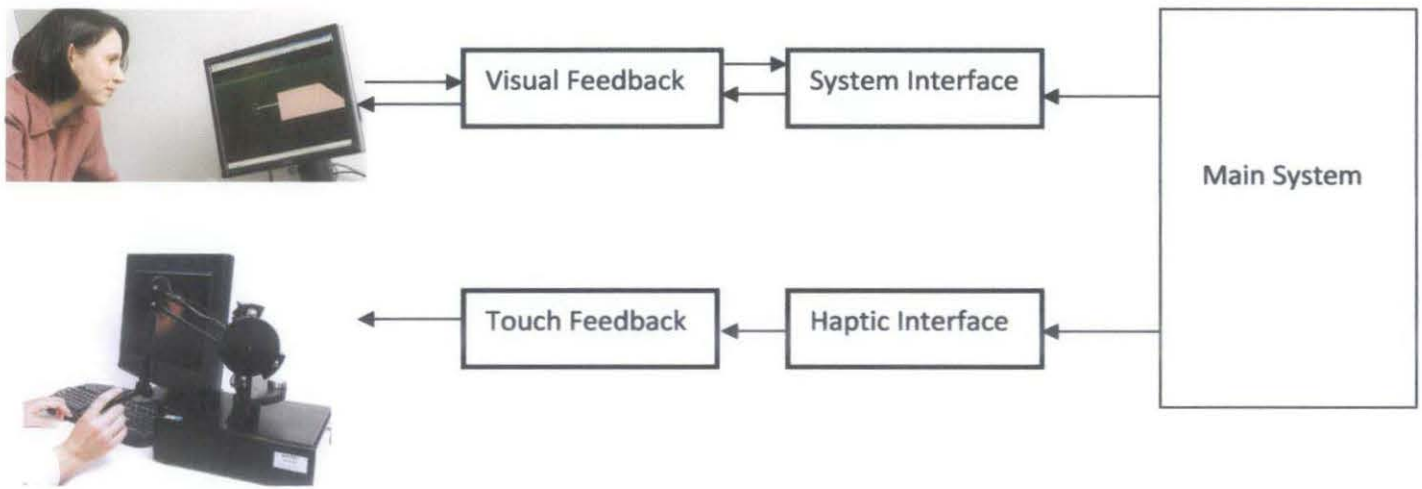


Figure 20: System Architecture

4.6. System Usecase

The Use Case shows the interactions of the users with the system. The users can only perform two tasks which are choosing the artefacts and feel the artefacts using the haptic device.

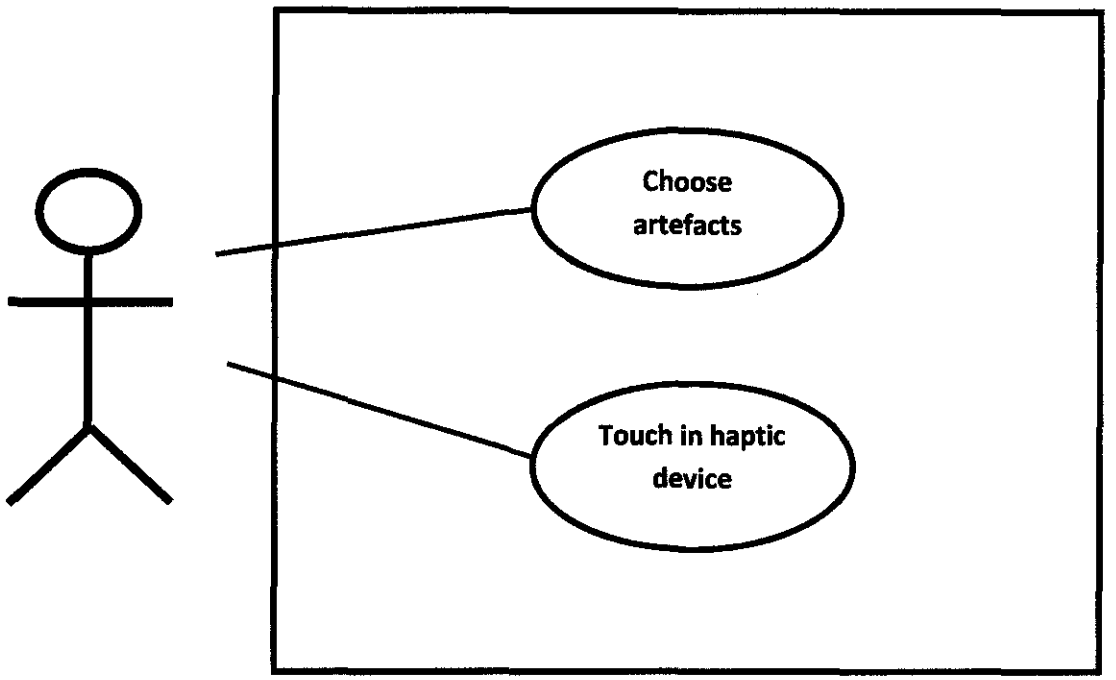


Figure 21: System Use Case

4.7. System Interface

4.7.1. First draft

Figure 22 shows the first draft of the user interface or the main page of the system. Users will encounter with this page first before starting the touch feedback. In this page, there are texts to show the name of the system and instructions. Also, there three buttons; artifact 1, artifact 2 and the exit button.

Moving to Figure 23, it shows the output when the users chooses the button for artifact 1 or artifact 2. At the center of the interface, the graphic of the artifacts will be shown and at this interface is where the haptic device will be used to feel the touch feedback. Moreover, in this interface there are buttons for exit and menu where the users can go back to the previous page which is shown in Figure 23

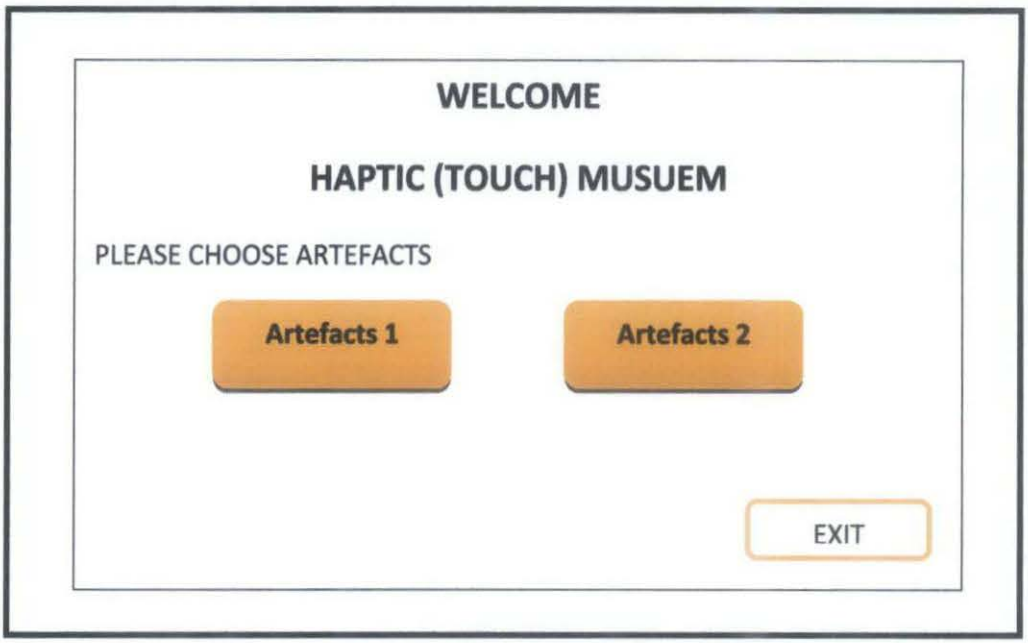


Figure 22: Main Page

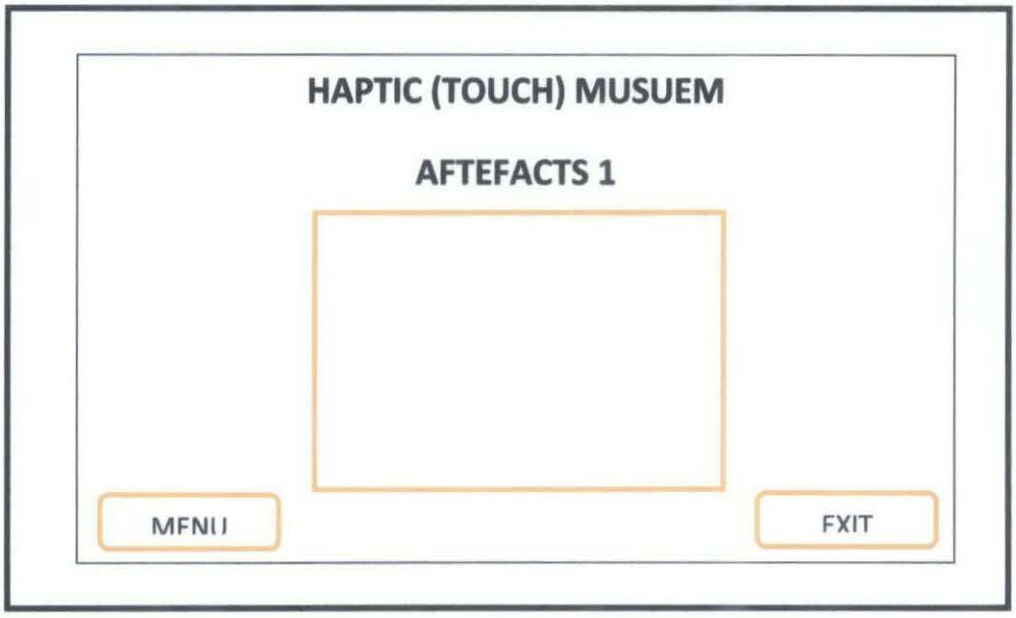


Figure 23: Displaying artefact's interface

4.7.2. Second draft

For the second draft, it is a web based application where it is created using HTML programming language. The user will come across the main page first with the heading of "Haptic (Touch) Museum" with different tabs and also a brief description of Haptic (Touch) Museums. This is shown in Figure 24.

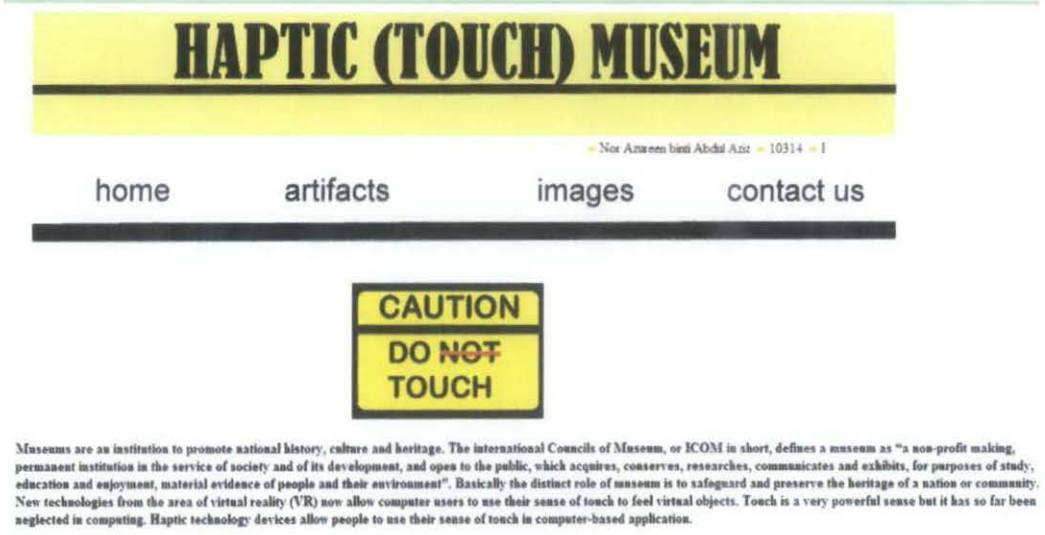


Figure 24: Main Page

While in Figure 25, it is a link from main page if the user clicks on the artifacts tab. In the artifacts page, the user will see a photo of the artifacts with the button "Touch" beside it. The "Touch" button will activate the haptic application and also it will show the virtual artefact.

Figure 25: Artifact's Page

CHAPTER 5
CONCLUSION AND FUTURE WORK

5.1.Conclusion

The main task was to understand the haptic technology and how it could be implemented into the culture application and in this case in the museum. From the research, haptic or force-feedback technology that is implemented in museum is not a new matter in western countries as there are already several museum that adapt haptic technology in there exhibitions.

With haptic technologies, visitors or even anyone in the world are able to feel a solid, three-dimensional object with different textures, hardness or softness. With the new technology in the culture industries, people are able to gain more insight rather than just view the artefacts without using their sense of touch. Additionally, providing a force-feedback to the visitors, it will enrich their experiences in museums and definitely could attract a wider audience.

5.2. Future Work

As a continuation for this project, several tasks have been planned out:

- Gather more information by interviewing the museum officer for more information that could help for the project
- Learn more on software that will be used.
- Build the model for the system

CHAPTER 6
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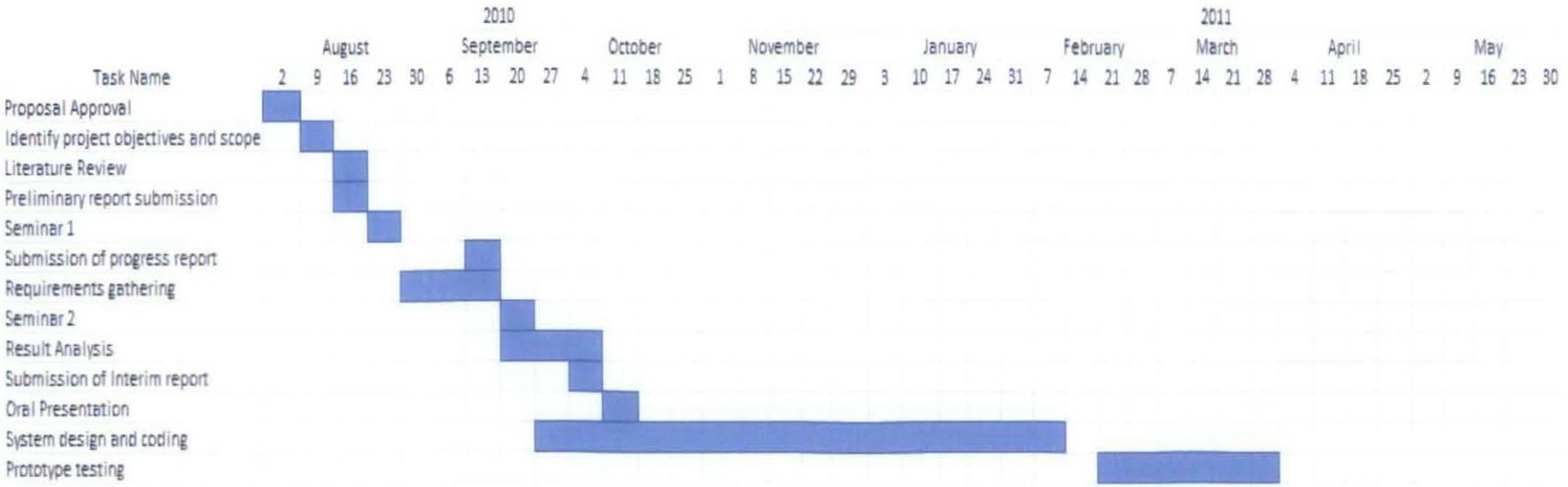
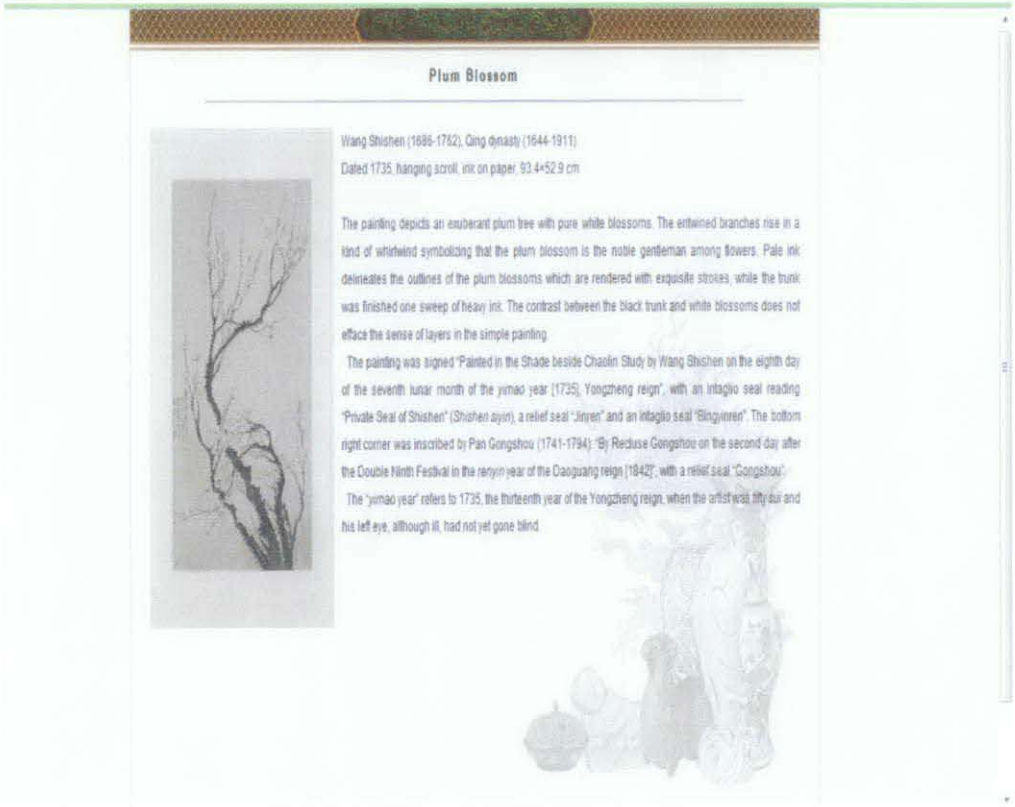
APPENDIX A


2010
2011
August
September
October
November
January
February
March
April
May
Task Name
2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 3 10 17 24 31 7 14 21 28 7 14 21 28 4 11 18 25 2 9 16 23 30
Proposal Approval
Identify project objectives and scope
Literature Review
Preliminary report submission
Seminar 1
Submission of progress report
Requirements gathering
Seminar 2
Result Analysis
Submission of Interim report
Oral Presentation
System design and coding
Prototype testing

APPENDIX B



Plum Blossom

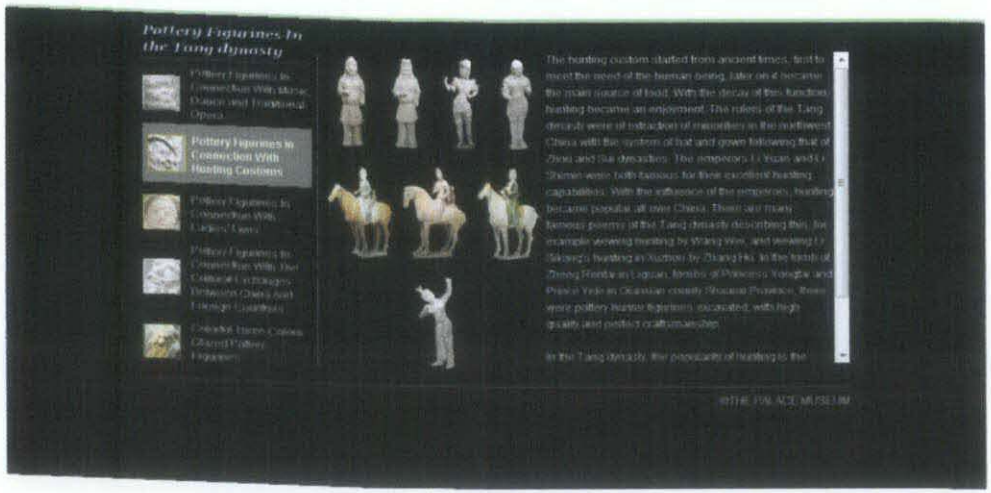
Wang Shishen (1686-1752), Qing dynasty (1644-1911)
Dated 1735, hanging scroll, ink on paper, 93.4×52.9 cm

The painting depicts an exuberant plum tree with pure white blossoms. The entwined branches rise in a kind of whirlwind symbolizing that the plum blossom is the noble gentleman among flowers. Pale ink delineates the outlines of the plum blossoms which are rendered with exquisite strokes, while the trunk was finished one sweep of heavy ink. The contrast between the black trunk and white blossoms does not efface the sense of layers in the simple painting.

The painting was signed "Painted in the Shade beside Chaolin Study by Wang Shishen on the eighth day of the seventh lunar month of the yimao year [1735], Yongzheng reign", with an intaglio seal reading "Private Seal of Shishen" (Shishen siyin), a relief seal "Jinyen" and an intaglio seal "Bingyinren". The bottom right corner was inscribed by Pan Gongshou (1741-1794): "By Recluse Gongshou on the second day after the Double Ninth Festival in the renyin year of the Daoguang reign [1842]", with a relief seal "Gongshou".

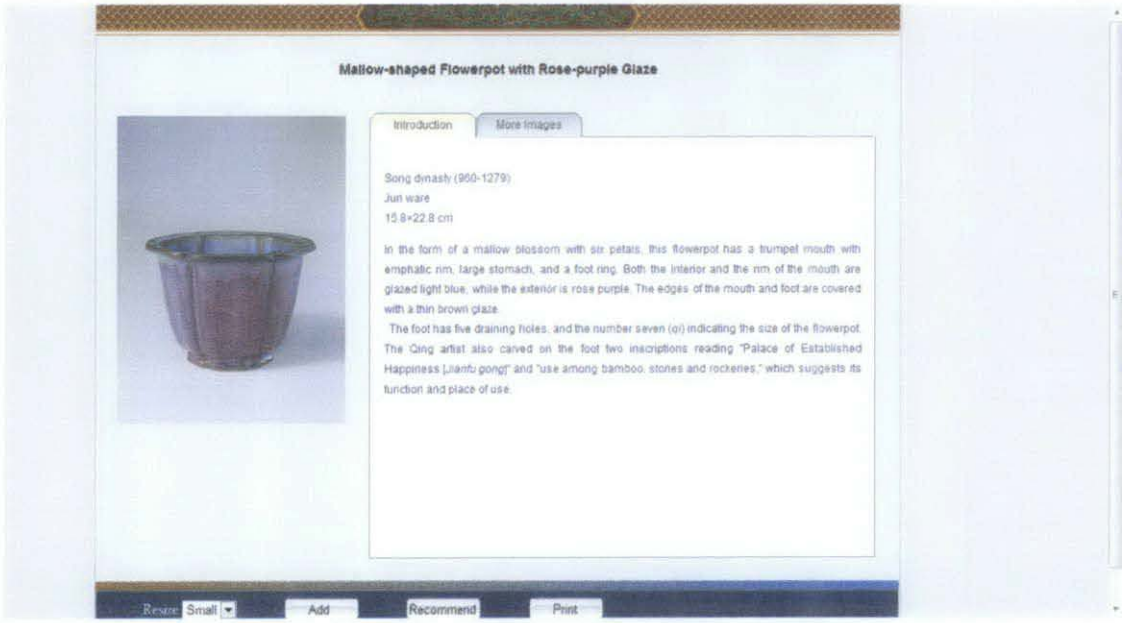
The "yimao year" refers to 1735, the thirteenth year of the Yongzheng reign, when the artist was fifty-four and his left eye, although ill, had not yet gone blind.

APPENDIX C


Pottery Figurines in the Tang dynasty
Pottery Figurines in Connection With Hunting Customs


yellow glazed pottery warrior

APPENDIX D


Mallow-shaped Flowerpot with Rose-purple Glaze
Introduction
More Images
Song dynasty (960-1279)
Jun ware
15.8×22.8 cm
In the form of a mallow blossom with six petals, this flowerpot has a trumpet mouth with emphatic rim, large stomach, and a foot ring. Both the interior and the rim of the mouth are glazed light blue, while the exterior is rose purple. The edges of the mouth and foot are covered with a thin brown glaze.
The foot has five draining holes, and the number seven (qi) indicating the size of the flowerpot. The Qing artist also carved on the foot two inscriptions reading "Palace of Established Happiness [Jianfu gong]" and "use among bamboo, stones and rockeries," which suggests its function and place of use.
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