**Virtual Show House**

by

Ity Nadira Binti Ahmad

Dissertation submitted in partial fulfillment of

the requirements for the

Bachelor of Technology (Hons)

(Information System)

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# CERTIFICATION OF APPROVAL

**Virtual Show House**

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A project dissertation submitted to the
Information System Programme
Universiti Teknologi PETRONAS
in partial fulfillment of the requirement for the
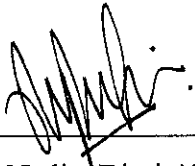BACHELOR OF TECHNOLOGY (Hons)
(INFORMATION SYSTEM)

Approved by,

_____
(Jafreezal Bin Jaafar)

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# 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 acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or person.

(Ity Nadira Binti Ahmad)

# ABSTRACT

Currently, housing developers in Malaysia have not produce a system where customers can view show house virtually via the internet. This project focuses on developing a virtual show house and integrating it in a website. The objectives of this project are to design a coherent virtual show house that enables customers which have interactive environment; to create a virtual reality show house that will give customers an overview of their current and future housing projects; to evaluate potential use of show house in house purchasing environment; to achieve the above objectives, the author has developed a methodology which consists of several phases to accomplish the project on time. It consists of four main phases which are Analysis, Design, Development and Implementation phase. Analysis is important as is this phase all information is gathered. Design phase is divided into two main parts. The first part consists of prototype design modeling, scene graph and requirements specification. The next part for the design phase would consist of test design prototype and hypothesis development. This part is vital to observe the development of prototype. The third phase of the methodology would be the development phase where prototype developed and implemented and lastly would be the analysis phase. For the analysis, 87.5 % of evaluators agree that the virtual show house would best be improve especially targeting in Smoothness of view changing and Ease of Navigation. In conclusion, that future development of this virtual show house can be an advantage for housing developers and well for the customers as it can save time and cost. The idea can be broaden by enhancing features stated in the recommendation.

# ACKNOWLEDGEMENT

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# CHAPTER 1

# INTRODUCTION

The increase in construction activity in Malaysia stimulated higher Government expenditure on infrastructure projects and supported by the construction of residential property in choice locations led to the construction sector registering an increased growth of 1.2 per cent (Department of Statistic Malaysia, 2003)[1]. With the increasing number of resident population in Malaysia with a number of 25.45 million (Department of Statistic Malaysia, 2004) *refer to Appendix A for details* [2], more property development projects are develop to satisfy the demand of housing areas.

In seeking to provide good quality new residential development, the ability to review proposed developments before construction will be increasingly important. Virtual reality (VR) enables environments to be created, that can be entered into and interacted with directly, greatly facilitating this process of visualizing, evaluating and communicating new design ideas. Virtual show house gives the opportunity for property developers housing team to advertise their new estate which gives customer a head view of the future housing projects.

The main concern of this project is to deliver a virtual three dimensional show house which can give an overview of representative house which will be offer for sale. Virtual reality is an imitation of reality, usually with the help of a computer, which provides the user with a combination of visual, auditory, and possibly, tactile information reflecting the actions of the user, giving the user the impression of being present in some reality. By using virtual reality as the main element in this system, it gives the opportunity for

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customers to walk through their dream house without having to visit the real show house which is located far from location.

## 1.1 Background of Study

Virtual reality was first developed by a man name Douglas Engelbart. He was a young engineer former naval radar technician who has the urged to develop a digital display. Not until 1960's that people started to accept his new ideas and vision. Back then virtual reality is being used only for military purposes. One of the influential virtual reality applications was the flight simulator. Aircraft designers began experimenting with ways for computers to graphically display, or model, air flow data. Computer experts began restructuring computers so they would display these models as well as compute them. The designers' work paved the way for scientific visualization, an advanced form of computer modeling that expresses multiple sets of data as images and simulations [3].

There are many definition of virtual reality made by many experts. Virtual reality can be defined as a collection of technology consists of gadgets such as head mounted display (HMD), glove input device and audio. But in reality we can define virtual reality as a new technology that can provide users with 3D experience without having the real thing there [4]. Overtime, virtual reality had played a big role in the 20th century. Virtual reality is being used for various applications such as Simulation, Education, Health care Telepresence or simulation of Hazardous or Remote Environments, Architecture, Scientific visualization and Entertainment [5]. The used of virtual reality are being used widely in representing an organization, life form or in other computer applications.

For this project, the author is responsible to produce a virtual reality show house for a housing developer company's website. The show house includes structure of the living room, kitchen, bedroom and toilets. It is also compile with various objects such as

furniture, cabinets, lights, door and etc to give the opportunity for buyers to experience a future virtual show house for a walk-trough experience without having to go to the real one which is far and cost more. The show house developed can be a good way to promote more sales from buyers who can access the internet.

## 1.2 Problem statement

Currently, housing developers in Malaysia have not produce a system where customers can view show house virtually via the internet. Problems may occur when buyers now are smart and they expect to get a good bargain in housing investment. Thus they want more rather than just a picture of the house they want to purchase, the floor plans and specifications. Buyers prefer to view various houses first before making any decision to purchase it.

Time constrains would be the next problem for customers as show houses are usually far from their house location. Therefore it would be a hassle for them to go from one house to another just to find that they don't like it and feeling frustrated later. Even though show houses are open daily from 9 am to 6 pm, there are no sales representatives to guide customers if there are any queries about the specification.

The need for the Virtual Home Buying System exists to assist owners of system as it gives them the opportunity to sell their property online thus gaining more customers worldwide. It also gives the power and freedom of choice to their customers to choose a house interactively within budget and needs. The ability of users of the system to conduct house purchasing virtually on their own, with minimal supervision, is what makes the development of such product a priority in this information technology era.

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## 1.3 Objectives and Scope of Study

### 1.3.1 Objectives

- To design a virtual show house that enables customers to experience interactive environment.

- To create a virtual reality show house that will give customers an overview of their current and future housing projects.

- To evaluate potential use of show house in house purchasing environment.

### 1.3.2 Scope of Study

This project will involve the production of a virtual reality show house to represent the original units build by the developers. It focuses on delivering the exact housing experience as similar to the show house built for customers by using virtual reality. Customers as viewers are able to explore into the house and experience real settings.

Based on the research identified, here are the project scopes which are as follows:

Determined and designed main elements of show houses which includes appropriate backgrounds and objects for example furniture, doors, windows, backgrounds and etc.

Develop a prototype to represent a show house. Users are able to move inside the house virtually, zoom to location and moves objects.

Test and validate prototype product.

To integrate prototype with participating system this will be develop by other representative.

# CHAPTER 2

# LITRETURE REVIEW

The conception of this project is to develop a virtual show house and integrating it with a web base application. The design and architecture of the show house is based on the structural design of several show rooms which has been analyzed in analysis phase in Chapter 3. The idea of this project is to deliver a virtual environment for users to view actual show rooms without having to go to the real place and settings.

## 2.1 Virtual Reality Definitions

There are many varying definitions and terms for virtual reality (VR), all of which could be considered accurate within certain circles of knowledge. Since the technology behind VR is still basically a new field, there are a lot of researchers, authors, and columnists giving out their own theories behind VR. Naturally, everyone offers a new and better definition from Myron Krueger's terminology which appeals more toward the lay person up to the much more accurate and technical definition by Howard Rheingold. Krueger defines VR as an "artificial reality."

"An artificial reality perceives a participant's action in terms of the body's relationship to a graphic world and generates responses that maintain the illusion that his actions are taking place within that world" (Krueger 1999).

In Krueger's artificial reality, art and science become interrelated, and the viewer interacts with and actually becomes part of the new simulated environment.

On the other hand Rheingold dove more into what actually makes up virtual reality. He states that: "The idea of immersion (using stereoscopy, gaze-tracking, and other technologies to create the illusion of being inside a computer generated scene) is one of the two foundations of virtual reality technology. The idea of navigation which is to create a computer model of a molecule or a city and enabling the user to move around, as if inside it) is the other fundamental element" (Rheingold 1991, 2002).

It is important to remember that these definitions are only two authors view points. Artificial Reality is probably the most dated of any definition, as it was dated back in the middle 1970. Since that time, specific projects have been started and further terms have been thrown around virtual worlds, virtual cockpits, virtual environments, and virtual workstations.

Finally, in 1989, Jaron Lanier, CEO of VPL Research Inc., stated the term virtual reality to encompass all of the virtual projects under a single phrase. This term refers (in general) to any three-dimensional reality implemented with stereo viewing goggles and "data"gloves.

Virtual reality is the simulation of a real or imagined environment that can be experienced visually in the three dimensions of width, height, and depth and that may additionally provide an interactive experience visually in full real-time motion with sound and possibly with tactile and other forms of feedback. The simplest form of virtual reality is a 3-D image that can be explored interactively at a personal computer, usually by manipulating keys or the mouse so that the content of the image moves in some direction or zooms in or out. Most of these images require installing a plug-in for your browser. As the images become larger and interactive controls more complex, the perception of "reality" increases. More sophisticated efforts involve such approaches as wrap-around display screens, actual rooms augmented with wearable computers, and joystick devices that let you feel the display images [6].

## 2.2 History of Virtual Reality

Since man first acquired the power of imagination we have felt the need to transport ourselves to different worlds, to places we could never physically visit, to see things never seen before. The Stone Age storytellers whose stories transported their listeners to mythical realms where the spirits dwelt, were some of the first exponents of the human need to explore alternate realities. In later centuries, after writing was invented, books replaced storytellers as a means of allowing the reader to explore new philosophical and social vistas. In the 20th century, the advent of the motion picture and television has led to a large proportion of humanity in the developed world spending almost as much time visiting these alternate realities as they do existing in their own reality.

The wave of technology in the 20th century that led to the motion picture, television also spawned the computer. At first the early generation computers did not seem to lend themselves to the exploration of imaginary realities, mainly due to the human-computer interface being very primitive. As computers progress from using punched cards, printouts to keyboards and Visual Display Terminals (VDT's) for communicating with their human creators. The computers potential use as a tool to create virtual worlds also started to evolve. As the VDT became more sophisticated it began to support graphics.

The developments in graphic displays prompted research in computer graphics, much of which was funded by industrial and military institutions interested in the potential of computers in simulation and data visualization. The early emphasis in this area lay in simple 2D data visualization, such as the development of a radar system that would process large amounts of data and immediately display it in a form that humans could readily understand for use in detecting nuclear attacks during the cold war. Later as computer hardware became more powerful, accurate 3D simulations of aircraft and tank warfare became possible. These developments led to a greater understanding of the

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technical requirements for VR such as rapid graphics frame updates, short lag times, visual cues, motion and force feedback.

While much early work in VR was concerned with military and industrial applications, artists and academics also saw the potential for the computer in creating virtual worlds. Conceptually one of the first VR systems was Morton Heilig's Sensorama [Hei1998] which used motion picture film combined with binaural sound, scents, winds and vibrations to engulf the user in a simulation of reality. Heilig's system lacked interactivity though as it limited the viewer to a pre-recorded motorcycle trip through New York with wind, noise and smells included.
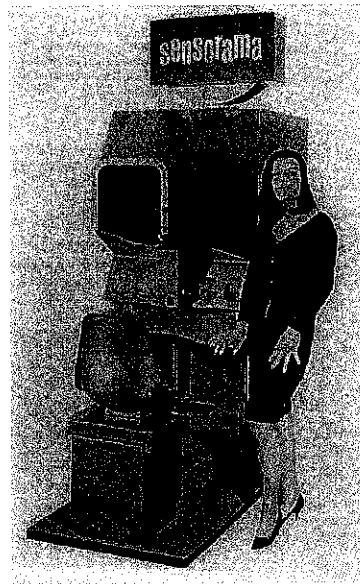


*Figure 1: Sensorama Machine*

One of the earliest serious VR researchers was Ivan Sutherland who in 1965 published a paper describing 'The Ultimate Display' [Sut1965] which described a technology that was a precursor to what we now know as Virtual Reality. Sutherland also pioneered the light pen and an early precursor to the head-mounted display [Sut1968]. Another early pioneer was Myron Krueger who, using 1970's technology, built a system to allow users in physically different locations to share documents using 'electronic fingers' to point at or edit document settings. He also built a primitive VR room with cameras tracking the user and projecting real time graphics of the user's gestures against the wall [Hei1998]. The term Virtual Reality itself was first used by Jaron Lanier [Bro1998] in the mid 1980's when first developing much of the VR hardware that has since become standard, such as the data glove, the head mounted display and the data suit for his company VPL. Although the term 'Virtual Reality' has since become a part of modern vocabulary, many researchers prefer the term Virtual Environments as being more accurate.

In the early 1980's two researchers at NASA Ames, namely Mike McGreevy and Jim Humphries, developed VIVED (Virtual Visual Environment Display) that has become the model for most contemporary VR setups [Hei1998]. Later the VIEW (Virtual Interactive Environment Workstation) project was also developed at Ames that provided a more advanced configuration including head and hand tracking, wide field of view head-mounted displays, speech recognition, 3D audio and a tracked instrumented glove. The VIEW system hardware is illustrated in Figure 2, while it is shown being used to virtually inspect a rock at Mars Hill in Death Valley, California, in Figure 3.

*Figure 2: View VR system in use*



*Figure 3: View system VR hardware*

In the 1990's as CPU's and graphic support chips became much more powerful and affordable and networking technology became more pervasive, advances in the use of VR accelerated with numerous new applications in diverse fields emerged [5].

## 2.3 Design and visualization with virtual reality

### 2.3.1 Design

Virtual Reality could revolutionize the process of design, not only because of its potential value as a communication and visualization tool, but because it offers a "trial run" in designing architecture [9].

Sherman and Judkins point out that "It is far easier to recognize potential difficulties, or actual mistakes, when moving around inside a design, rather than looking at 2D plans from the outside. Most instances of Murphy's Law are caused by a lack of sufficient preparation or forethought. VR provides the opportunity to do the one, and exercise the other. Furthermore, it is possible to repeat the virtual tours until there is a satisfactory outcome." [10]

Virtual Reality in Architecture is an area in which virtual reality has tremendous potential is in architectural design. Various walk-through designs are build that allow designers and clients to examine homes and office buildings, inside and out, before they're built. With virtual reality, designers can interactively test a building before construction begins.

### 2.3.2 Visualization

All architects, regardless of their visualization ability, innate or developed through years of practice, will have a better chance to visualize when using Virtual Reality.

Today, 3D computer modeled animations allow visualizing using a two dimensional screen. The architect/client can visualize the design fairly easily using computer-generated animations. However, there are limits to "believability" (related mainly to

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display techniques and power requirements) which VR attempts to overcome. Improved visualization through the use of VR in architectural practice will clearly benefit both the architect and the client [9].

## 2.4 Example of virtual house
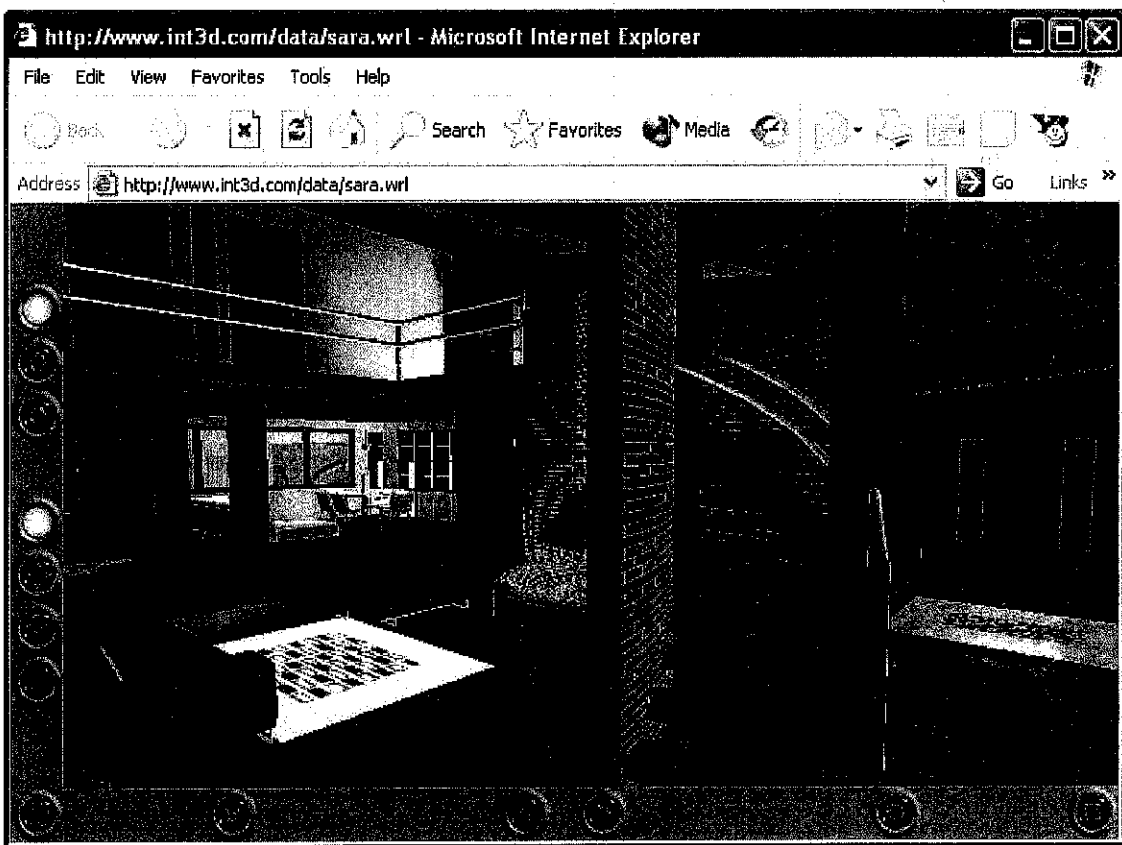


*Figure 4: Example of Virtual House*

Above is a picture of virtual houses on the Internet [11]. Most of the houses are build using VRML codes and other architectural software for example AUTO CAD. In this virtual house, users can walk, rotate and examine the house by using navigation button located at the left and bottom of scene. Such show house is only available in the US market.

## 2.5 Scene Graph Designing Concepts

A scene graph describes the geometry and behavior of a 3D scene or environment. Scene graphs have been around for a long time. The scene graph is a directed, acyclic graph, sometimes called a "tree." There are many specialized properties of this type of graph, illustrated by the directed, acyclic graph of the family tree. Acyclic means that you can't be the parent of your grandfather; there are no loops in the family tree. Directed can be explain that the parent-child relationship is a one-way proposition. The edge between your parent and you represents a special kind of relationship that exists in just one direction [7].

The scene graph is also a directed, acyclic graph (DAG), or tree, consisting of nodes and edges. Elements of the scene that have some data component, such as viewable objects, light sources, camera locations and so forth are contained in the graph nodes. The edges in the scene are like the edges in the family tree, they define not only parent-child relationships, but also, and more importantly, scope of influence of scene parameters.

The following figure shows the relationship between APIs using scene graphs and the lower level graphics languages:
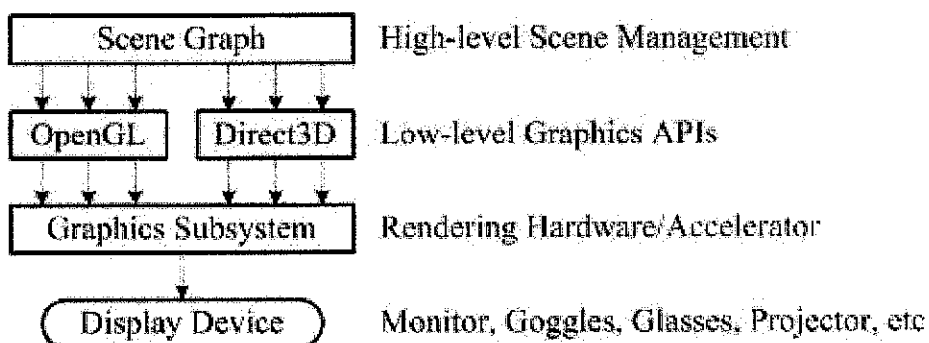


*Figure 5: Relationship between APIs using scene graphs*

### 2.3.1 Scene Graphs as Trees

A generic scene graph might take the following form:
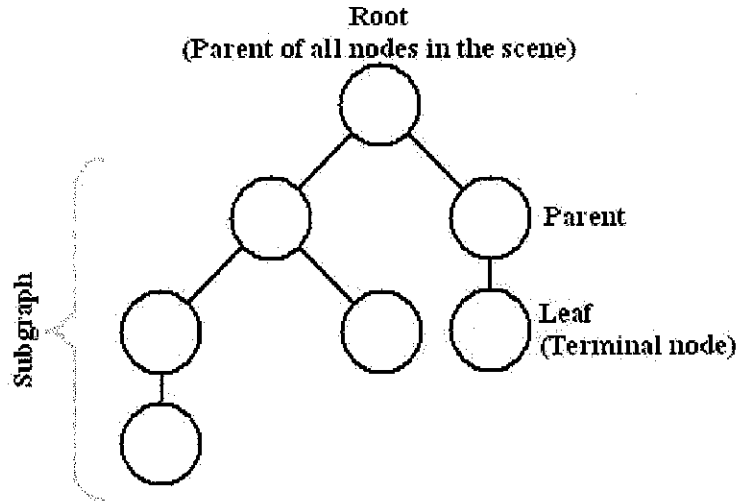


*Figure 6: Example of scene graph tree*

Scene graphs consist of nodes that represent objects in a scene which is connected by arcs (edges that define relationships between nodes). Together, nodes and arcs produce a graph structure that organizes a collection of objects hierarchically, according to their spatial position in a scene. Operations on the scene can be performed on all nodes in the graph, or they may be restricted to a particular sub graph (scenes can therefore be composed of individual nodes as well as entire sub graphs that may be attached or detached as needed) [8].

# CHAPTER 3

# METHODOLOGY

## 3.1 Procedure Identification

The author has developed a methodology which consists of several phases to accomplish the project on time. This researched project consists of four main phases which are analysis phase, design phase, development phase and implementation phase.

The methodology started with the analysis phase. This phase is critical to help analyze the possible drawbacks and opportunities of this project in the future by gathering information of its development prospect.

The second phase would be the design phase. The author has divided the phase into two main parts. The first parts consist of prototype design modeling, scene graph and requirements specification. In the prototype modeling phase, the development of the show house is designed. Designs are referred to the data gathered in the previous phase. In the requirements specification phase, software and hardware product is determined to design and construct the show house. The next part for the design phase would consist of test design prototype and hypothesis development. This part is vital to observe the development of prototype.

The next part of the methodology would be the development phase. Here, the modeling is defined and developed. The model would later be integrated with a website in the integration phase.

After prototype has been integrated, it will later be implemented and undergo testing and evaluation phase. Data gathered during evaluation phase will be analyzed for the final prototype.

| Analysis Phase |
|:---:|
| ▪ Information Gathering |
| ▪ Information Analysis |

↓

| Design Phase | |
|:---:|:---:|
| **Phase 1** | **Phase 2** |
| ▪ Prototype Design Modeling | ▪ Test design prototype |
| ▪ Develop Scene Graph | ▪ Hypothesis development & |
| ▪ Requirements specification | design |

↓

| Development Phase |
|:---:|
| ▪ Prototype Modeling |
| ▪ Prototype Integration |

↓

| Implementation Phase |
|:---:|
| ▪ Prototype implementation |
| ▪ Evaluation and data collection |

↓

| Data Analysis And Result |
|:---:|

*Figure 7: Project Framework*

## 3.2 Analysis Phase

### 3.2.1 Information gathering

Analysis phase consist of two main stages which are information gathering and information analysis. In this stage, various data are collected and gathered to attain information which supports the project and the researched sustaining documents.

The purposed of data being collected is to identify the issues regarding the field of study that is conducted. This is a process of moving from research topic to a researchable problem which involves sharpening of concepts and narrowing of scope.

There are two main issues being focused in data gathering. The first issue would be to gather information regarding existing show house and how we can deliver the same environment in virtual reality. Meanwhile the second issue focuses on solving navigation problems in virtual reality applications.

Various methods are used to gather information for the analysis phase. Methods include;

- Conduct a formal interview session with Bousted Holding Berhad regarding house purchasing information.
- Collect facts, information and supporting researched documents from Internet, journals, books and etc.
- Test and observe existing virtual reality application and how navigation and interaction are applied to application.

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### 3.2.2 Information Analysis

All collected data are analyzed and segregated as all information are important to aid the design and development phase. The author had used information available to help specify the types of virtual reality application and determined the tools needed for developing the project. The information of the show house is important in determining the layout of the prototype to be built and the size of layout. After all specification is prepared, the author will move to the next phase which is the design phase.

### 3.2 Design Phase

The design phase is divided into two main phases. The first phase includes three stages which are prototype design modeling, scene graph development and requirements specifications. This part is mainly focused on modeling and determining the specification needed for developing the product. Meanwhile the next phase includes two main stages as well, which are test design prototype and hypothesis development.

### 3.2.1 Prototyping Design Modeling

Show house building is designed and constructed using 3D development tool such as 3D Studio Max. The house are constructed based on real show house with modification with fits the environment. All objects and character are also designed using 3D Studio Max. Textures are applied to the model to give the realism to the model. There are three main part of the house which the author will design. The first part would be the first floor or ground floor of the show house. Next, would be the second floor and lastly is the outdoor view of the house.

### 3.2.2 Develop Scene Graphs

Scene graph is a tree. It contains reusable data. It is typically drawn schematically with the root at the top, leaves at the bottom. It all starts with a top-most root node which encompasses your whole virtual world, be it 2D or 3D. The world is then broken down into a hierarchy of nodes representing either spatial groupings of objects, settings of the position of objects, animations of objects, or definitions of logical relationships between objects such as those to manage the various states of a traffic light. The leaves of the graph represent the physical objects themselves, the draw able geometry and their material properties.

### 3.2.3 Requirements Specification

Tools and equipment are important to ensure development of the prototype. With the correct tools used, development process will be much easier. Tools are software used to carry out prototype modeling and also virtual environment. Meanwhile equipments are the hardware used such as desktop and specifications.

- **Software tools**

*Table 1: Software list and description*

| Software | Description |
|---|---|
| 3D Studio Max 6.0 | 3D Studio Max is modeling software that helps to built 3D models. All prototype models in this project are constructed using this software. It has a user friendly development tools which allows easy manipulation of objects and textures. |

| Cortona | Cortona is a state-of-the-art visualization technique which allows users to gain detail insight of 3D objects. Project prototype which has been developed in 3D Studio Max first needed to be export into .wrl format before using this software to manipulate the environment and allowing users to navigate and interact. |
|---|---|
| Microsoft Notepad | This tool is used to write functions and codes for the .wrl files. Codes are used to insert textures and other information such as adding sensor to objects and collision detection. |

- ■ **Equipments**

*Table 2: Equipment list and description*

| Equipments | Description |
|---|---|
| Personal Computer | Personal computer is used to built and develop objects and initial model of virtual show house.<br>Processor: Pentium 4 2.8 HT<br>Operating system: Microsoft XP Professional<br>RAM : 516 MB |
| LCD screen | LCD screen is used to view the virtual environment on the active panel for the output visualization of this project. |
| Mouse | Mouse is used to navigate and as an interaction input device for this project. |

### 3.2.4 Test design prototype

During designing phase, we may encounter several phases which we have to test the prototype model. Personal testing is done to ensure that the prototype is concurrent with the environment overall settings. Thus when each time a new object model is created, the file will be exported to .wrl format to ensure that the models fit in the environment created and the texture used is suitable for the show house.

### 3.2.5 Hypothesis Development Design

Hypothesis is important for an analysis of evaluation of product prototype. Hypothesis consist statistic of collected data which will be gathered in the data analysis stage where all data is converted into useful tables of descriptive statistic and histogram charts for better visualization of the result. A basic formula is applied to determine whether a hypothesis is accepted or rejected.

The hypothesis of this project is 'improvement in navigation and realism'. There are two hypotheses that will be conducted. First would be the pre usability inspection which will be conducted before conduction evaluation and next is the post usability inspection after they had navigated the prototype. The analysis will be based on how users navigate the show house. The hypothesis is as below:

> *The evaluation: Improvement in navigation and realism.*
> *HO: there is no improvement in navigation and realism*
> *HA: there is improvement in navigation and realism*

From the descriptive statistic, the attribute of improvement in navigation and realism is shown: Find range (R) and mean overall; M (O) as bellow:

| Attribute Improvement in Navigation and Realism | Mean |
|---|---|
| A1 | M1 |
| ● | ● |
| ● | ● |
| A2 | M2 |
| ● | ● |
| ● | ● |
| An | Mn |

A1, A2................ An = attributes

M1, M2 ................ Mn= mean for each attributes

---

Range ( R ) = M(max)-M(min)

Overall Mean, M(overall) = M1+ M2.............+ Mn

$$n$$

---

## 3. 3 Development Phase

### 3.3.1 Prototype final modeling

Final modeling conducted to ensure all objects are developed properly. In this stage, texture will also be implemented. Other features for example adding sensor and background to model will be develop here to add realism to the show house develop.

### 3.3.2 Prototype integration

When development of the model is finish, the prototype will be integrated with a website developed by Sharifah Shahrizad. She has developed an e-business website for house developers. Here the show house is included as a house model which buyers can view

real house via the internet and navigate around it. After integration system testing is done to ensure that the prototype is compatible with the website developed.

## 3.4 Implementation Phase

### 3.4.1 Prototype Implementation

Integrated prototype will be implemented and used in this phase for real time users. The objective of this stage is to deliver a completely functioning prototype which satisfies the main objective of the project. The implementation phase also includes an assessment of Evaluation to determine whether the prototype operates properly.

### 3.4.2 Evaluation and Data Collection

This phase is an evaluation and data collection phase. The purposed of this evaluation is to determine the acceptability of the end prototype, of how good it is and how well it matched the objective which is to design a coherent virtual show house that enables customers which have interactive environment.

- **Evaluators Profile**

Eight students from V4-c are chosen to evaluate the prototype. Each of the evaluators is given a set of questions before and after they had evaluated the prototype. Four of them are familiar with virtual reality application while the other four who are not familiar with the virtual reality application.

- **Methods of conducting evaluation**

During evaluation phase, the Evaluators are required to navigate the developed prototype. Evaluation id divided into two phases. The first evaluation is the pre usability inspection which is conducted before the navigators navigates the prototype to know their knowledge of virtual reality. The next evaluation will focus more on the feasibility design

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of the prototype and how smooth the navigation process is. There are two types of questions methods that I will conduct to collect data first would be Closed-Ended questions and for the next method would be Rang-of-response questions. Handouts of both methods will be used as a form to collect data and information. Closed ended question are a set of question with Yes and No answers. Meanwhile Range-of-response questions are closed-ended questions that ask the person to evaluate something by providing limited answer to numeric scale of 1-5.

- **Pre Usability Inspection**

The purpose of pre usability inspection is to know the knowledge of the evaluators which virtual reality navigation.

- **Post Usability Inspection**

Meanwhile, post usability inspection is to asses the overall quality of prototype. The evaluation verifies whether the prototype meets its specification requirements and complies with objectives and can offer suggestion for future improvements.

## 3.5 Data Analysis

In this stage, all data will be collected and analyze. The data will be calculated and will be tabulated in the statistic table. Summary of data will be shown by using a histogram graph for better visualization and evaluation. Details of data analysis will be showed in Chapter 4.

# CHAPTER 4

# RESULTS AND DISCUSSION

## 4.1 Result and Discussion for Design Phase

### 4.1.1 Scene Graphs

In the designing phase, there is a section where the author needs to develop a scene graph before developing the prototype. Here is an overview of the scene graph created by the author.
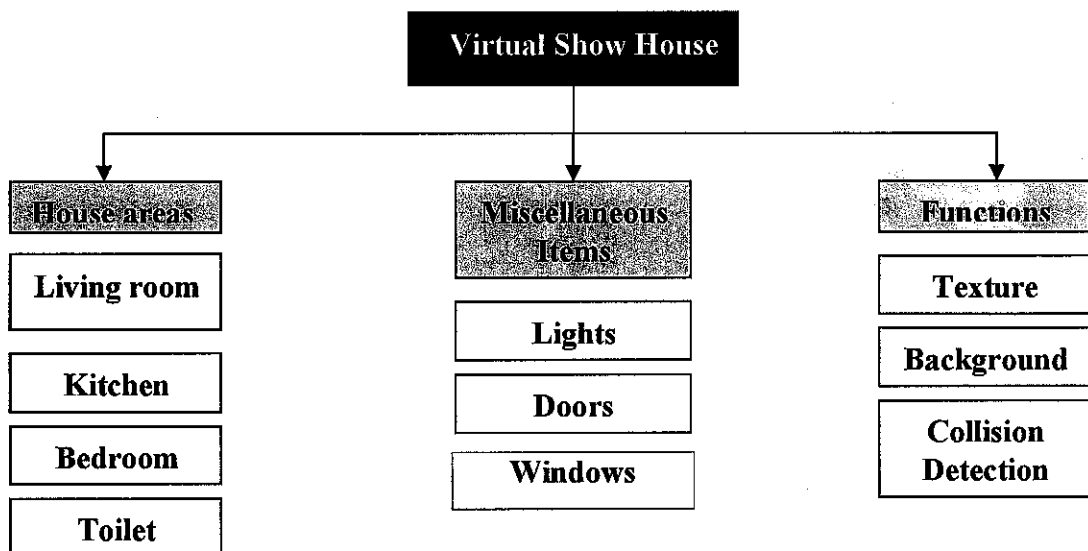


*Figure 8 : Scene Graph Structure*

By viewing the scene graph, we can clearly see the structure of the virtual show house. The scene graph is divided into several parts to allow better manipulation and clearer project management. The top of the scene graph which is black in color represents the root prototype. Meanwhile the grey box represents the parents of each node. Bellow each node consist of leafs which is a sub graph of each node. Together, each scene represents a

graph structure that organizes a collection of objects hierarchically, according to their spatial position in a scene. Each leafs is compiled with detail child information. The detailed information of each nodes, leaf and child of each scene can be referred in *Appendix B.*

## 4.2 Evaluation 1:Pre Usability Inspection

This evaluation is conducted before implementation phase. The objective of this test is to gain analysis of users' perspective of virtual reality to represent real show house. In this evaluation, the evaluators are given a set of closed-ended questions. Evaluators are required to tick Yes or No to the given questions. Questions prompted are basically to check if they are familiar with virtual reality applications or not.

*Table 3: Histogram result of evaluation for Pre usability Inspection*
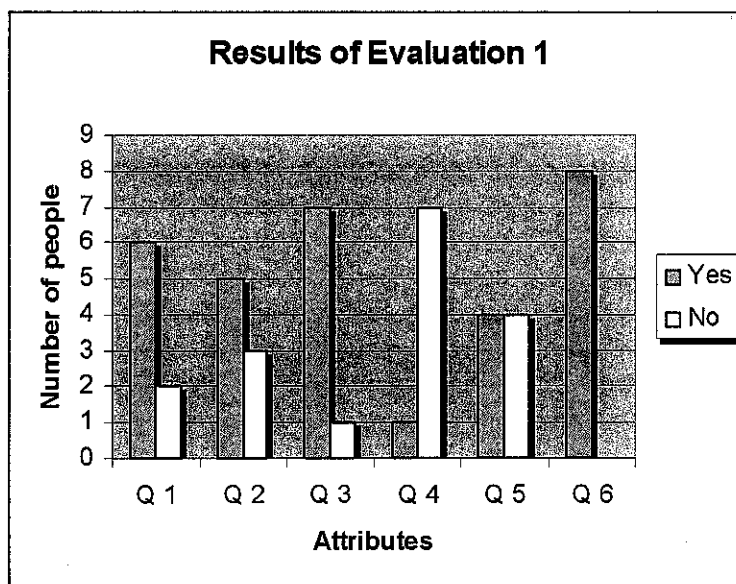


There are six different questions to evaluate evaluator's knowledge of virtual reality's application. For question one, six out of eight people have seen and navigate virtual reality applications for which the author assumes that 75% of the evaluators are familiar with it.

The second question indicates that five out of three people which are 62.5% of the evaluators have used virtual reality before to create 3D objects and are familiar with the

## 4.3 Result and Design and Implementation Phase

During development phase, the virtual show house and objects are modeled and developed. Figure below shows show the result of the complete framework in the design and development phase.
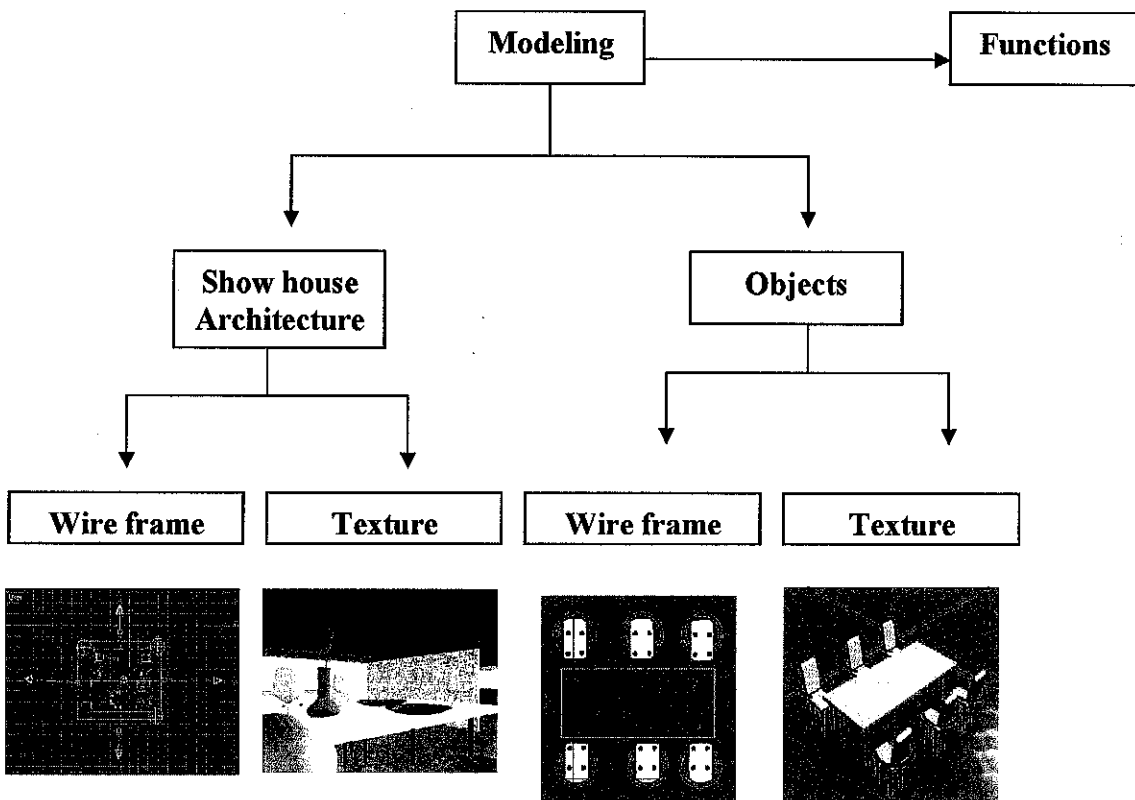


*Figure 9: Complete framework of development phase*

The first step of this phase is to model a building using 3D Studio Max. Walls and floors are building using polygons to develop a structured house. Next texture is inserted by importing it in the 3D Studio Max library.

When show house architecture is complete, the author then modeled objects to be inserted together with the show house. Objects includes chairs, table and etc. details of objects are listed in the scene graphs for each scenes. Certain objects are taken from the internet and 3D Max library. The complete results of the show house are shown below:
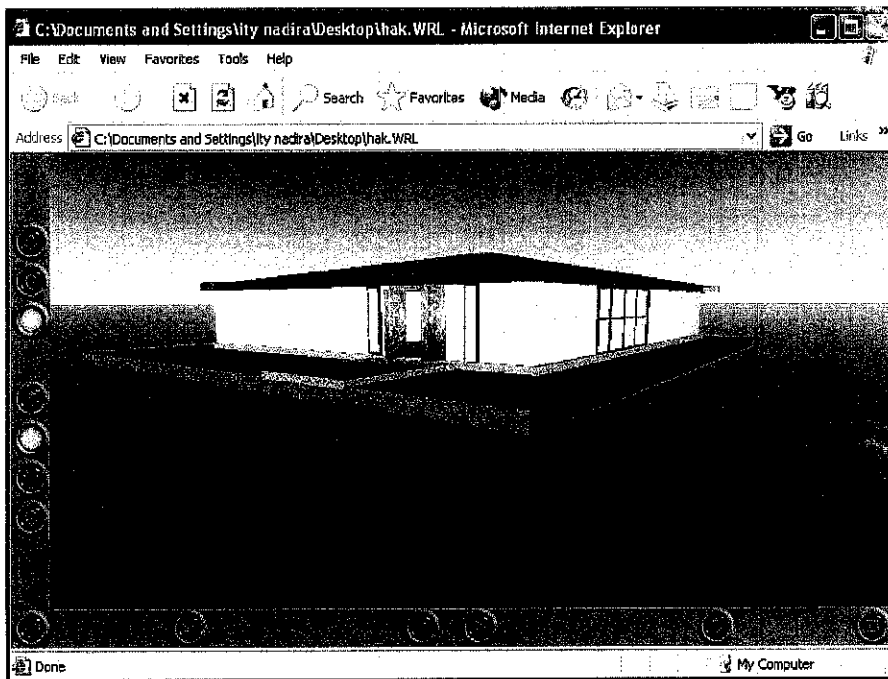


*Figure 10: Outside view*

*Figure 11: Living Room*
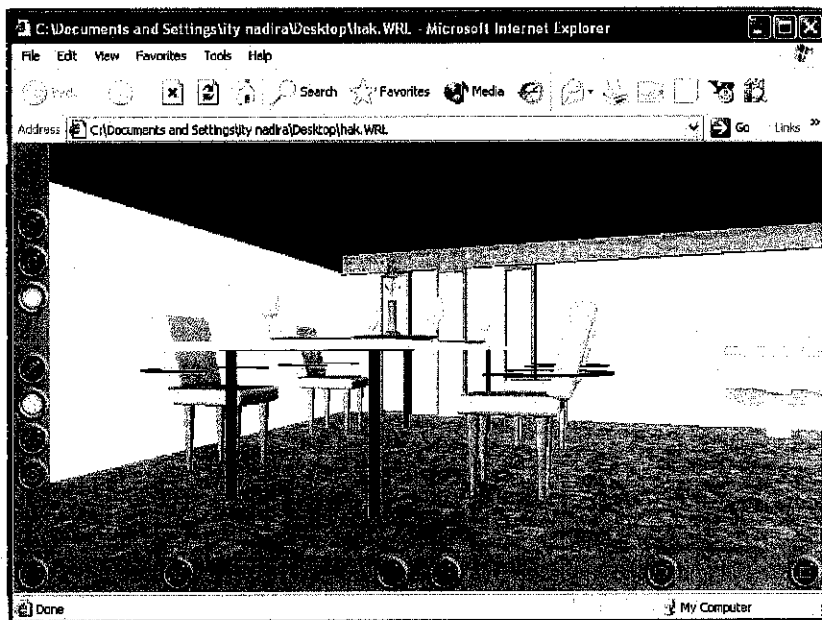


*Figure 12: Dining Room*
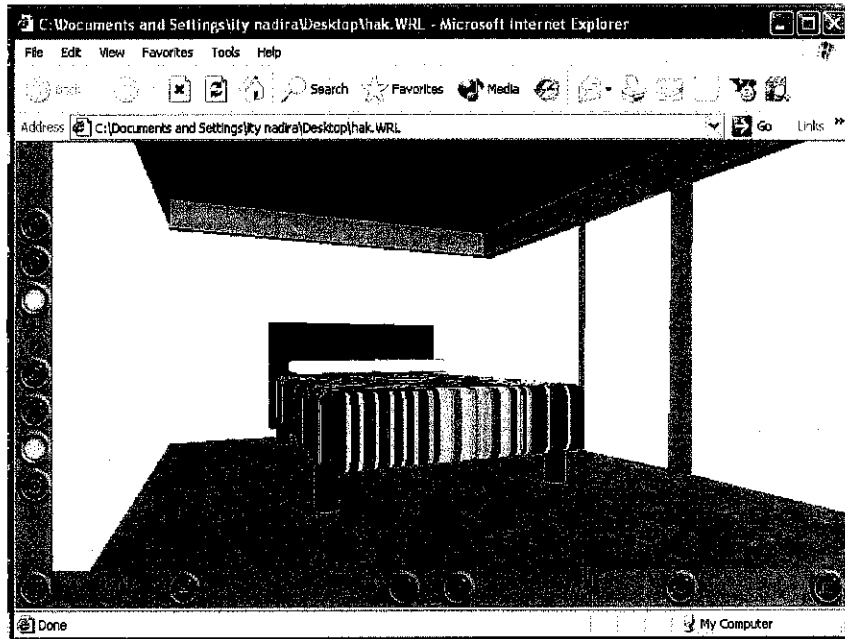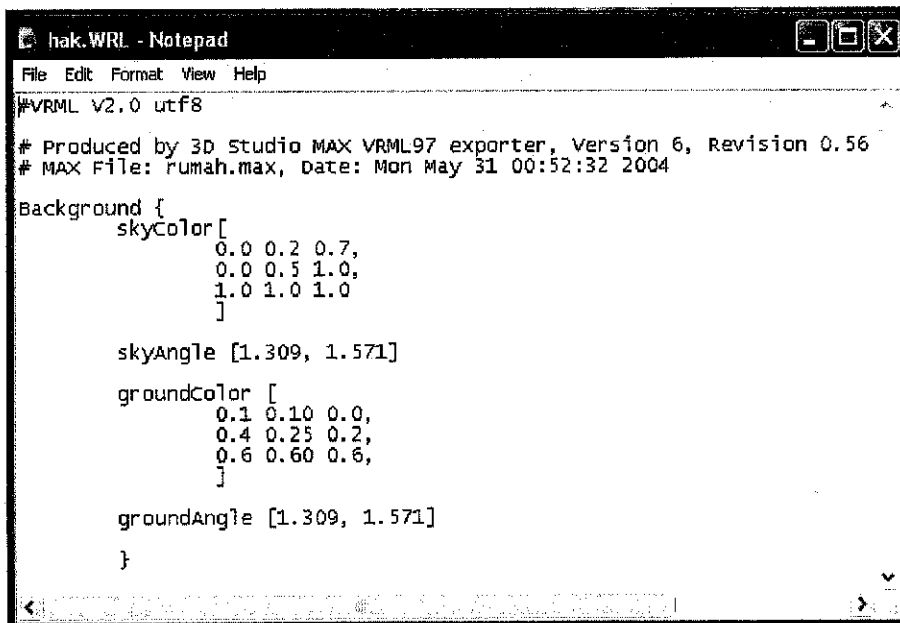
*Figure 13: Bedroom*
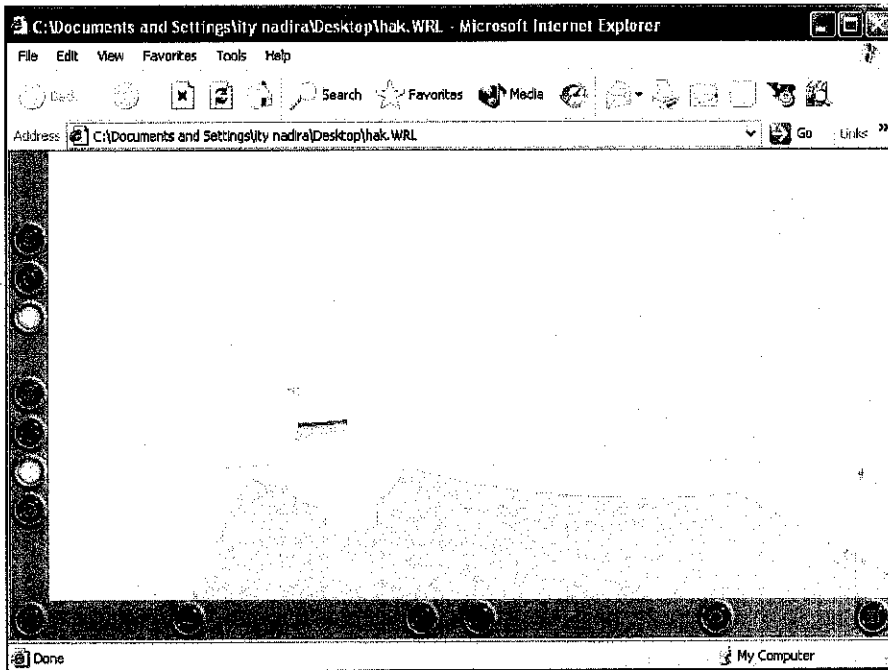


*Figure 14: Bathroom*

Subsequent to the modeling stage, the show house is exported into VRML (.wrl) format. The VRML file can be view by using a VRML navigation tool which is Cortona. Texture, shading and background can also be inserted in the function to add realism to the show house. To edit further manipulation, functions can be edited in the notepad.

Background can be an additional feature in the virtual house to add more realism in the environment. The background can be added by including further coding in the existing VRML code. Below is an example of VRML code of background and its result:

```
 hak.WRL - Notepad
File  Edit  Format  View  Help
#VRML V2.0 utf8

# Produced by 3D Studio MAX VRML97 exporter, Version 6, Revision 0.56
# MAX File: rumah.max, Date: Mon May 31 00:52:32 2004

Background {
        skyColor [
                0.0 0.2 0.7,
                0.0 0.5 1.0,
                1.0 1.0 1.0
                ]

        skyAngle [1.309, 1.571]

        groundColor [
                0.1 0.10 0.0,
                0.4 0.25 0.2,
                0.6 0.60 0.6,
                ]

        groundAngle [1.309, 1.571]

        }
```

*Figure 15: Background Function*
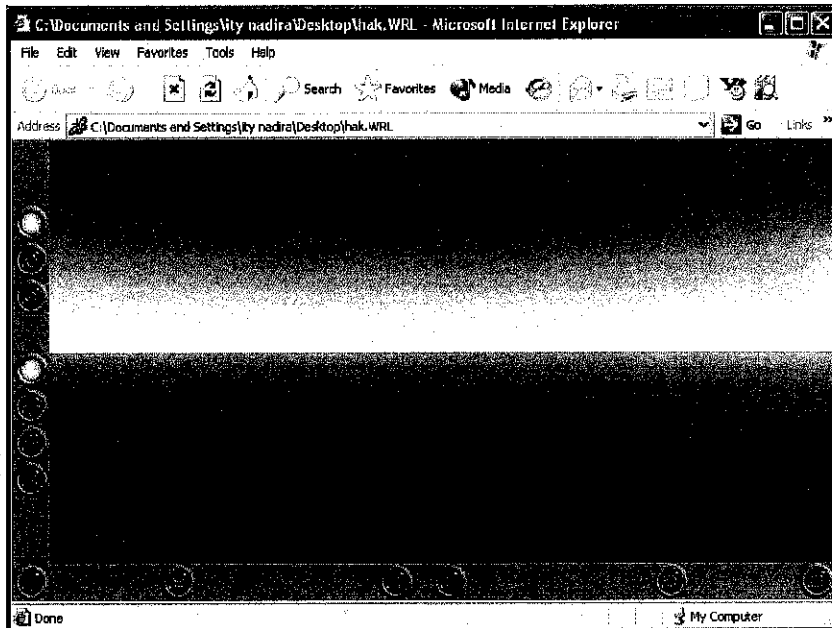
*Figure 16: Sky Background*

Meanwhile texture is also an important element to ensure of adding realism in overall environment. Below is an example of VRML code of texture and its result:



*Figure 17: Texture Function*

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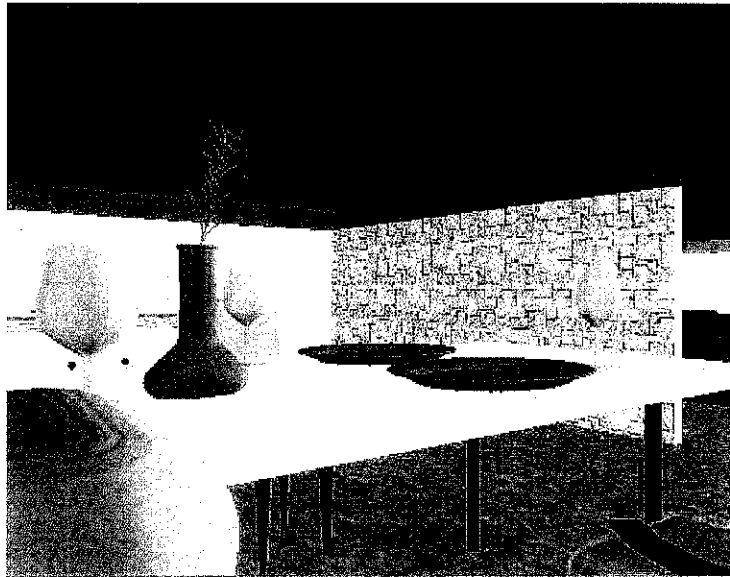
*Figure 18: Brick wall texture*

Collision detection is the function that control user from walking through walls and objects while navigation in virtual environment. Users are not allow walking trough these objects and have to find another way to navigate. This collision detection adds realism to the show house as in the real world we cannot walk trough an object.



*Figure 19: Collision Detection Function*

## 4.4 Evaluation 2:Post Usability Inspection

In this evaluation, the evaluators are asked to try the prototype and evaluate the prototype based on the checklist given. In this second evaluation, the questions are more focus on the aspect of realism and navigation smoothness. Table

*Table 4: Statistic of Evaluation for Evaluation 2 - Navigation and Realism*

| Attributes | N | Min | Max | Sum | Mean |
|---|---|---|---|---|---|
| 1. Realism of virtual show house | 8 | 3 | 5 | 31 | 3.9 |
| 2. Placements of objects in virtual show house | 8 | 3 | 5 | 28 | 3.5 |
| 3. Smoothness of view changing | 8 | 2 | 4 | 25 | 3.1 |
| 4. Realism of texture choose | 8 | 3 | 5 | 28 | 3.5 |
| 5. Ease of Navigation | 8 | 2 | 4 | 21 | 2.6 |
| Valid n | | | | | 8 |
| Mean Overall | | | | | 3.3 |
| Range | | | | | 1.3 |

*Table 5: Histogram of result of mean for Post Usability Inspection*



**Results of Evaluation 2**
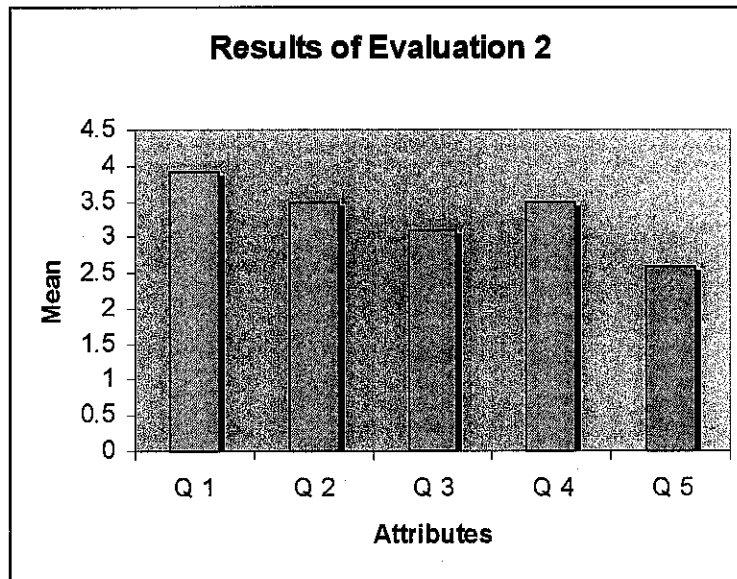
Hypothesis of project

*The evaluation: Improvement in navigation and realism.*
*Ho: there is no improvement in navigation and realism*
*HA: there is improvement is navigation and realism*

From the result of Evaluation 2, the minimum mean for the range is 2.6 while the maximum range is 3.9. The range for this section is 1.6 and the mean overall is 3.3. The results from this section had indicates that R<M. With R values is smaller than M values, the hypothesis of this evaluation can be accepted. Although the hypothesis has proven true, there are areas which the author needs to look in detail which is the smoothness of view changing. Overall average Viewers find it hard to move around the show house.

Analysis of post usability inspection has proven that the hypothesis (HA: there is improvement is navigation and realism) can be accepted as true. Although the hypothesis

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can be accepted, there need to be improvements in Smoothness of view changing and Ease of Navigation section where both questions had have the lowest mean in the table. With the improvement of both areas, virtual show house will be more realistic.

From the evaluation, 87.5 % of the evaluators think that the show house can be improved. They had suggested adding more features and animations for future enhancement. House areas should also be expended and more rooms should be included in the house in the future.

# CHAPTER 5

# RECOMMENDATION AND CONCLUSION

## 5.1 Summary of Project

This project had managed to achieve the initial objectives of designing and developing a coherent virtual show house that enables customers which have interactive environment. During the development of the project, many valuable experiences are gain trough out building the perfect show house in virtual environment. There are few restraints which are not having enough time and unfamiliarity of software which had contributed to limitations of end product. Limitations include unable to add collision detection code due to software inabilities and limitation of VRML coding knowledge. Although there are many obstacles during the first stages of development phase due to low knowledge of virtual reality, the author had managed to finish up building up the prototype on time with helpful tutorials from friends and Mr. Jafreezal. Many new experience are also obtain during producing the prototype such as able to produce 3D objects using 3D Studio Max and Cortona. The author was able to learn and manipulate VRML languages in time to achieve the objective of developing virtual show house.

The first evaluation of this project stated that users are not ready yet to purchase a house by just viewing a virtual reality show house but it will be a good way of representing a real show house to customer in future times. Meanwhile the second evaluation most of evaluators think that the show house can be improved. They had suggested adding more features and animations for future enhancement. House areas should also be expended and more rooms should be included in the house in the future.

## 5.2 Recommendation

There are many opportunities for this project to be enhanced and improve in the future. Here are the recommendations and that can be included for future enhancement.

- **Adding more texture to improve realism**

Texturing is important give viewers the feel of realism. To give the show house more realistic feel, life like texture of real objects for example wood interface can be imported to give a gist of visiting the real show house. Proper lighting and shading is also important to ensure the realism of the objects.

- **Include more sensor and animations**

By including more sensors and animation, users can interact better with the environment. A virtual character can be added to guide customers during navigations. With it users will be more familiar with the house details and direction. The virtual character can also be improved by adding sound and animation. With this feature, the virtual show house will be more users friendly and add realism to show house environment as they can manipulate and control the objects located in the room environment.

- **Using real measurements scale to design houses**

Virtual show house can be improve by using real measurements of house and scale it down to fit the virtual environment. To achieve this recommendation, the author suggests that the architecture of the entire house must be build using AUTO CAD software. By using this software, real objects can be scale down to smaller measurements.

- **Use more interaction during navigation**

To add interaction with users, the author proposed to add audio in collision detection. By adding audio, it will act as an alarm when users hit any walls and objects during navigation. With this, users will be more alert where they should be navigating. Virtual environment should also ensure the smoothness of the navigation process is control.

- **Adding virtual reality hardware to view prototype**

The project can also be enhanced by using other virtual devices such as Head Mounted Display (HMD) and manipulation and control device such as data gloves. By using these devices better interaction with the virtual environment can be obtain.

## 5.3 Conclusions

In conclusion, the author had managed to develop a virtual show house and environment. The author had produced a virtual reality show house for a housing developer company's to sell their houses by providing a model of their future house in the website as a marketing strategy. The show house developed can be a good way to promote more sales from buyers who can access the internet. The research of this project had proven that the future development of this project can be an advantage for housing developers and well for the customers as it can save time and cost. Not only does it benefits the users to view future house via the internet and save time, it also can save cost of building a real show house and buying real furniture that will later be sell on a lower price which doesn't benefit at all. The study of this project had also contributed to further study of virtual reality exploration, navigation and interaction.

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# APPENDICES


# LIST OF APPENDIX

# Appendix A: Malaysian Populations

Data Penting - Keys Statistics

Go To  <Selection/Pilih>

**Updated on 01 Apr. 2004**

| PENDUDUK [1] *Population* | | 2002 | 2003 | 2004 Suku 1 1st Qtr. |
|---|---|---|---|---|
| Penduduk (juta) *Population (million)* | | 24.53 | 25.05 | 25.45 |

**Appendix B: Scene Graphs Details**

- **House areas**

**1. Living Room**

| Object | Texture | Texture format | Functions |
|--------|---------|----------------|-----------|
| Sofa | brown leather | jpg | |
| Cabinets | wood | jpg | |
| table | Wood, glass | jpg | Transparent glass |
| Television | black | jpg | |
| Carpet | Carpet design | jpg | |
| Plants | Green, brown | jpg | |
| Floor | Marble | jpg | |
| Walls | Brown , cream | jpg | |

**2. Kitchen**

| Object | Texture | Texture format | Functions |
|--------|---------|----------------|-----------|
| Kitchen table | Wood, glass | jpg | Transparent glass |
| Chairs | Cream garment | jpg | |
| Cabinets | Wood | jpg | |
| Sink | Metallic | | |
| Oven | Metallic white | | |
| Plates | Flower motif | jpg | |
| Glasses | Blue | | Transparent |
| Floor | Wood | jpg | |
| Walls | Brown, cream | jpg | |

### 3. Bedroom

| Object | Texture | Texture format | Functions |
|--------|---------|----------------|-----------|
| Bed | Wood | jpg | Transparent glass |
| Bed covers | Quilt | jpg | |
| Cabinets | Wood | jpg | |
| Plants | Flower | jpg | |
| Glasses | Blue | jpg | Transparent glass |
| Floor | Marble | jpg | |
| Walls | Blue | jpg | |

### 4. Toilet

| Object | Texture | Texture format | Functions |
|--------|---------|----------------|-----------|
| Toilet bowl | Wood | jpg | |
| Sink | Quilt | jpg | |
| Shower | Glass | jpg | Transparent glass |
| Floor | White Marble | jpg | |
| Walls | Black marble | jpg | |

- **Miscellaneous Items**

### 1. Lights

| Object | Texture | Texture format | Functions |
|--------|---------|----------------|-----------|
| Table lights | Metal grey | jpg | Switch on and off |
| Stand Lamp | Metal black | jpg | Switch on and off |
| Ceiling lights | Clear | jpg | Switch on and off |

## 2. Doors

| Object | Texture | Texture format | Functions |
|---|---|---|---|
| Front door | Metal grey | jpg | Open door |
| Standard door | Metal black | jpg | Open door |

## 3. Windows

| Object | Texture | Texture format | Functions |
|---|---|---|---|
| Windows | Glass | jpg | Transparent<br>Slide window |

- **Functions**

| Collision detection | Walls, objects |
|---|---|

## Appendix C: Pre Usability Inspection

## Evaluation Checklist
## Evaluation 1: Pre Usability Inspection

Please tick your answer. If you answer no, please state your reasons.

1. Have you ever seen or navigate virtual reality application before?

   ☐ Yes ☐ No

   _____

2. Have you used virtual reality to create a 3D object?

   ☐ Yes ☐ No

   _____

3. Do you think virtual reality can represent real objects?

   ☐ Yes ☐ No

   _____

4. Have you ever encounter a developer website which provides VR show house before?

   ☐ Yes ☐ No

   _____

5. Will you ever consider purchasing a house by just viewing it trough the internet?

   ☐ Yes ☐ No

   _____

6. Do you think virtual reality will play a big role in representing a show house in the future?

   ☐ Yes ☐ No

   _____
   **Raw Data**

## Evaluation 1: Pre Usability Inspection

### Question 1

| Yes | 6 |
|-----|---|
| No  | 2 |

### Question 2

| Yes | 5 |
|-----|---|
| No  | 3 |

### Question 3

| Yes | 7 |
|-----|---|
| No  | 1 |

### Question 4

| Yes | 1 |
|-----|---|
| No  | 7 |

### Question 5

| Yes | 4 |
|-----|---|
| No  | 4 |

### Question 6

| Yes | 8 |
|-----|---|
| No  | 0 |

# Appendix D: Post Usability Inspection

## Evaluation Checklist

## Evaluation 2: Post Usability Inspection

Please tick your answer. If you answer no, please state your reasons.

### 1. Realism of virtual show house

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|

Not Realistic                    Moderate                    Very Realistic

### 2. Placements of objects in virtual show house

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not Smooth | | Moderate | | Very Smooth |

### 3. Smoothness of view changing

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not Organize | | Moderate | | Very Organize |

### 4. Realism of texture choose

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Not Real | | Moderate | | Very Real |

### 5. Ease of Navigation

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Very Hard | | Moderate | | Very Easy |

6. Do you think this virtual show house can be improved? YES / NO

**Evaluation 2: Post Usability Inspection**
**Question 1**
Realism of virtual show house

|  | Data |
|---|---|
| Evaluator 1 | 3 |
| Evaluator 2 | 4 |
| Evaluator 3 | 5 |
| Evaluator 4 | 3 |
| Evaluator 5 | 4 |
| Evaluator 6 | 4 |
| Evaluator 7 | 5 |
| Evaluator 8 | 3 |
| **Sum** | **31** |
| **Mean** | **3.9** |

**Question 2**
Placements of objects in virtual show house

|  | Data |
|---|---|
| Evaluator 1 | 3 |
| Evaluator 2 | 3 |
| Evaluator 3 | 3 |
| Evaluator 4 | 4 |
| Evaluator 5 | 4 |
| Evaluator 6 | 5 |
| Evaluator 7 | 3 |
| Evaluator 8 | 3 |
| **Sum** | **28** |
| **Mean** | **3.5** |

**Question 3**
Smoothness of view changing

|  | Data |
|---|---|
| Evaluator 1 | 3 |
| Evaluator 2 | 3 |
| Evaluator 3 | 4 |
| Evaluator 4 | 4 |
| Evaluator 5 | 4 |
| Evaluator 6 | 3 |
| Evaluator 7 | 2 |
| Evaluator 8 | 2 |
| **Sum** | **25** |
| **Mean** | **3.1** |

## Question 4
Realism of texture choose

|  | Data |
|---|---|
| Evaluator 1 | 5 |
| Evaluator 2 | 3 |
| Evaluator 3 | 3 |
| Evaluator 4 | 4 |
| Evaluator 5 | 3 |
| Evaluator 6 | 3 |
| Evaluator 7 | 4 |
| Evaluator 8 | 3 |
| Sum | 28 |
| Mean | 3.5 |

## Question 5
Ease of Navigation

|  | Data |
|---|---|
| Evaluator 1 | 2 |
| Evaluator 2 | 2 |
| Evaluator 3 | 3 |
| Evaluator 4 | 4 |
| Evaluator 5 | 3 |
| Evaluator 6 | 2 |
| Evaluator 7 | 2 |
| Evaluator 8 | 3 |
| Sum | 21 |
| Mean | 2.6 |

## Question 6
Do you think this virtual show house can be improved?

|  | Data |
|---|---|
| Evaluator 1 | YES |
| Evaluator 2 | YES |
| Evaluator 3 | YES |
| Evaluator 4 | YES |
| Evaluator 5 | YES |
| Evaluator 6 | NO |
| Evaluator 7 | YES |
| Evaluator 8 | YES |
| % Yes | 87.5% |
| % No | 12.5% |

# Appendix E: Project Milestone

| NO | PROJECT SCHEDULE | week | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| 1 | Selection of Project Topic | | | | | | | | | | | | | | | | | | | | | | |
| | Proposed topic | | | | | | | | | | | | | | | | | | | | | | |
| | View topic assigned by supervisor | | | | | | | | | | | | | | | | | | | | | | |
| | Create Methodology | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Analysis Phase | | | | | | | | | | | | | | | | | | | | | | |
| | Information Gathering | | | | | | | | | | | | | | | | | | | | | | |
| | Information Analysis | | | | | | | | | | | | | | | | | | | | | | |
| 3 | Design Phase | | | | | | | | | | | | | | | | | | | | | | |
| | Prototype Design Modeling | | | | | | | | | | | | | | | | | | | | | | |
| | Develop Scene Graph | | | | | | | | | | | | | | | | | | | | | | |
| | Requirement Specification | | | | | | | | | | | | | | | | | | | | | | |
| | Test Design Prototype | | | | | | | | | | | | | | | | | | | | | | |
| | Hypothesis Development | | | | | | | | | | | | | | | | | | | | | | |
| 4 | Development Phase | | | | | | | | | | | | | | | | | | | | | | |
| | Prototype Modeling | | | | | | | | | | | | | | | | | | | | | | |
| | Prototype Integration | | | | | | | | | | | | | | | | | | | | | | |
| 5 | Implementation Phase | | | | | | | | | | | | | | | | | | | | | | |
| | Prototype Implementation | | | | | | | | | | | | | | | | | | | | | | |
| | Evaluation & data collection | | | | | | | | | | | | | | | | | | | | | | |
| 6 | Data Analysis | | | | | | | | | | | | | | | | | | | | | | |
| 7 | Report Submission | | | | | | | | | | | | | | | | | | | | | | |
| 8 | Oral Presentation | | | | | | | | | | | | | | | | | | | | | | |
| | Internal Presentation | | | | | | | | | | | | | | | | | | | | | | |
| | External Presentation | | | | | | | | | | | | | | | | | | | | | | |
| 9 | Submission of Project Dissertation | | | | | | | | | | | | | | | | | | | | | | |