Department of Electronic Engineering

FINAL YEAR PROJECT REPORT

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Development of Three Dimensional Hong Kong Disneyland on the Internet - I

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Bachelor of Engineering (Honours) in Information Engineering
Student Final Year Project Declaration

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Project Title: Development of Three Dimensional Hong Kong Disneyland on the Internet - I

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Date:
Acknowledgements

VRML is a simple language which can be viewed with most web browsers. That is the reason why VRML was very famous on the internet. However, making VRML world is a very time-consuming task, especially building the shapes of 3D objects.

During the development of the VRML world, I learned many things from it. I have to thank my supervisor, Dr. Peter Tsang, to assist me starting the project. It is always a hard work to commence a task. With respect to this project, the most difficult thing to be overcome is how to start building an object, and which part of an object should I build first? This question was resolved quickly when meeting with Dr. Tsang.

I also want to thank my assessor, Dr. Ricky Lau. He inspired me with a brainstorm to think about a question after FYP oral presentation. What is the contribution of this project?

At last, I have to thank my teammates, Katy and Andy. Although this project is not officially called group project, we carried out the project together as we have the same project topic and same site to build. We always communicate and exchange the information learnt during the project development. As a partner of them, I learnt time management of my project when I noticed that my progress was behind theirs. This will help in my future job.
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Abstract

In general speaking, web pages are usually presented in form of text with pictures. As web programming being maturely developed, more interactive stuffs can be added into web pages, but so far those stuffs are mostly showing in 2D format. As a result, 3D stuffs, such as VRML, will become the future trend. VRML, which stands for Virtual Reality Modeling Language, is used to build a 3D space on the Internet. By installing plug-in, a web browser can be used to view VRML world. Some softwares help to build the VRML world, such as Internet Space Builder.

This project aims to develop 3D Hong Kong Disneyland with VRML. The project is divided into three parts, developing by three different students. My part is to build the Fantasyland of HK Disneyland, including Sleeping Beauty Castle, Cinderella Carousel, Dumbo the Flying Elephant, and some other attraction points. Compared to the VRML projects in past few years, the size of the virtual world is relatively small. However, the composed components of each real building are very complicated as detailed decorations and irregular shapes are used. To make the world more realistic, much of the time was consumed on building the Sleeping Beauty Castle, which is the center building of the HK Disneyland.
Chapter 1  Introduction

1.1  Objectives

The main objective of this project is to build three-dimensional Hong Kong Disneyland on the web. Among the 3D modeling languages, this project make use of VRML (Virtual Reality Modeling Language).

Hong Kong Disneyland is divided into four theme parks and comprises a lot of buildings with detailed decorations. For this reason, the whole building process is done by three students, and my part is to build “Fantasyland”. This project is mainly focused on the level of details, so the buildings were built as much detailed as possible.

Figure 1.1  Map of Hong Kong Disneyland.
1.2 Motivation

Regular web page, like the following one, may be gotten when surfing on the internet.

![A common web page components](image)

Figure 1.2 A common web page components (Web3D Consortium)

This page contains text, hyperlink, image, and form. By installing specific plugin, more interactive stuffs can be added to a plain web page, such as Flash objects and PDF documents. These web page components are maturely developed, but almost all of them are presented in two dimensional format.

As a result, 3D web was developed. Although 3D web is not a new invention, not many web pages are three dimensional.

2D web gives information to users, but 3D web gives experiencing chance to users. There are virtual tours, virtual colleges and virtual training on the internet. You may take a look at a place, so that you can get experience of the virtual viewing and walking. This is the reason of 3D web superior to 2D web.

As a result, 3D virtual tours on Hong Kong International Airport, Ocean Park and Hong Kong Island were separately implemented in the past year, which show the practical use of 3D web. This project continued the previous aim, and implemented Hong Kong Disneyland.
1.3 Project Overview

As a group project, division of work had been done at the beginning. Hong Kong Disneyland is divided into four theme parks:

- Main Street, U.S.A.
- Tomorrowland
- Fantasyland
- Adventureland

My part is to build the 3D Fantasyland. The following main objects of Fantasyland were developed in the virtual world:

- Sleeping Beauty Castle
- Cinderella Carousel
- Mad Hatter Tea Cups
- Royal Banquet Hall

In addition, some animations were added into the objects to increase their realism.

![Figure 1.3 Map of Fantasyland of Hong Kong Disneyland.](image-url)
Chapter 2  

2.1  VRML

2.1.1  What is VRML?

VRML, which is pronounced as “ver-mal”, stands for Virtual Reality Modeling Language. VRML is a modeling language to describe three dimensional objects and worlds. VRML is different from general purpose programming languages like C and C++, or script language like Javascript, but it is a scene description language used to describe the geometries, colours and animations of 3D objects.

VRML is able to be shared over an intranet and the internet with suitable plug-ins installed to the web browsers. Once a VRML world is loaded, it is allowed to walk around the world and view a 3D object.

Figure 2.1  Example showing a simple sphere and a simple cylinder
2.1.2 History of VRML

VRML history can be traced back to 1994, when the “First International Conference on World Wide Web” was held. At that time, VRML was stands for “Virtual Reality Markup Language”, because of its cue from HTML, “Hypertext Markup Language”.

The first draft of VRML specification was presented at the World Wide Web Conference in fall 1994. VRML version 1.0 was concluded in 1995. However, VRML 1.0 has very limited functions. It only allows specifying static scenes.

The most recent version of VRML is 2.0, or called VRML 97. This version was proposed in 1997. It allows animations and multimedia (sound, video) to be added to the VRML objects and world. Moreover, VRML 2.0 allows scripts like Java and Javascript to be added for behaviour changes.

In this project, VRML 2.0 was being focused to build the 3D world.
2.1.3 VRML File and Structure

VRML file ends in .wrl extension, which indicates VRML “world”. Some may end with .wrz or .wrl.gz, which is the extension of VRML world in gzip compressed form. Regular VRML file, which is non-compressed, is a plain UTF-8 or ASCII text file. Similar to HTML files, VRML files are convenient to be created and edited with simple text editors.

The main elements of VRML files include a header and nodes. VRML header is a compulsory element to tell the browsers it is a VRML file and the version number with encoding type. For VRML 1.0, the header is:

```
#VRML V1.0 ascii
```

For VRML 2.0, the header is:

```
#VRML V2.0 utf8
```

After the header, all the syntaxes are case-sensitive. VRML files use hierarchical structures called “scene graph”. Scene graphs define a collection of objects, or namely called “nodes”. It also defines the nodes ordering. Generally, most things are nodes.

Here is an example of VRML object with simple node:

```
#VRML V2.0 utf8
Transform { 
  translation 1 0 1 
  children [ 
    Shape { 
      geometry Sphere { 
        radius 1.0 
      } 
    ] 
  ] 
}
```

Figure 2.3 A simple 3D object with sphere node
Nodes contain node types, a set of curly braces, fields and field values. The following table summarizes the node types and nodes.

<table>
<thead>
<tr>
<th>Node types</th>
<th>Nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grouping nodes</td>
<td>Anchor, Billboard, Collision, Group, Inline, LOD, Switch, Transform</td>
</tr>
<tr>
<td>Geometry nodes</td>
<td>Box, Cone, Cylinder, ElevationGrid, Extrusion, IndexedFaceSet, IndexedLineSet, PointSet, Sphere, Text</td>
</tr>
<tr>
<td>Appearance nodes</td>
<td>Material, ImageTexture, PixelTexture, MovieTexture, TextureTransform, Texture Coordinate</td>
</tr>
<tr>
<td>Interpolator nodes</td>
<td>ColorInterpolator, CoordinateInterpolator, NormalInterpolator, OrientationInterpolator, PositionInterpolator, ScalarInterpolator</td>
</tr>
<tr>
<td>Bindable nodes</td>
<td>Viewpoint, NavigationInfo, Fog, Background</td>
</tr>
<tr>
<td>Light source nodes</td>
<td>DirectionalLight, PointLight, SpotLight</td>
</tr>
<tr>
<td>Others</td>
<td>WorldInfo, Sound, AudioClip</td>
</tr>
</tbody>
</table>

Table 2.1 A List of nodes belonging to different node types.
Besides, VRML defines following keywords.

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Function</th>
<th>Usage example</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEF</td>
<td>Give a name for a node</td>
<td>DEF NewNode</td>
</tr>
<tr>
<td>USE</td>
<td>Use back a defined node</td>
<td>USE NewNode</td>
</tr>
<tr>
<td>ROUTE</td>
<td>Define a path between a node generating an event and a node receiving an event</td>
<td>ROUTE Node.eventOut TO Node.eventIn</td>
</tr>
</tbody>
</table>

Table 2.2  Some VRML defined keywords and their functions.

2.1.4  VRML standard units

By default, VRML 2.0 has its own standard unit system.

<table>
<thead>
<tr>
<th>Unit type</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear distance</td>
<td>Meters</td>
</tr>
<tr>
<td>Angles</td>
<td>Radians</td>
</tr>
<tr>
<td>Time</td>
<td>Seconds</td>
</tr>
<tr>
<td>Colour space</td>
<td>RGB (with 3 component values, each between 0 and 1)</td>
</tr>
</tbody>
</table>

Table 2.3  VRML 2.0 standard units.
2.1.5 Why VRML is used?

Although VRML has been established for many years, it still has superiority prior the other 3D modeling languages.

1. Easily distributed

VRML world can be viewed with either a VRML viewer or VRML plug-in ready web browser. So, basically, VRML can be viewed by all users on the internet. Thanks to the permission from VRML 2.0 to allow GZIP compression, file size of VRML file can be greatly reduced. As a result, VRML files can be further easily distributed over the internet.

2. Platform independent

Even if the system is operated under Microsoft Windows or Linux or any other systems, VRML files still work on them. It is just needed to get a copy of compatible viewer, or a VRML plug-in enabled web browser. Then, you can view the VRML worlds.

3. Open standard

VRML is an open standard as well as international standard. That means no licence has to be charged when developing VRML worlds. VRML has been registered in the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) with standard code (ISO/IEC-14772-1:1997). Therefore, many famous 3D modeling programs have an option to export their own files to VRML format.
2.2 VRML Modeling Tools

Throughout this project, some softwares were used in order to maintain more efficient work on VRML modeling.

2.2.1 VrmlPad

VrmlPad is a text editor developed by Parallel Graphics. It is the main software used to create the VRML files in this project. It has the following features:

1. Auto Complete
   
   When an alphabet character is typed, a drop-down list will be shown to show the possible appropriate VRML identifiers.

2. Errors detection

   If error is detected by the editor, it will underline the error context and show the error message in the status bar.

Figure 2.4 VrmlPad logo

Figure 2.5 VrmlPad auto complete function

Figure 2.6 VrmlPad errors detection function
3. Syntax highlighting

VrmlPad supports customizable syntax highlighting for VRML.

![VrmlPad syntax highlighting function](image1)

**Figure 2.7** VrmlPad syntax highlighting function

2.2.2 Material Editor for VrmlPad

This is a plug-in for VrmlPad for mapping colors to shape nodes effectively.

![Material Editor for VrmlPad](image2)

**Figure 2.8** Material Editor for VrmlPad.

2.2.3 Internet Space Builder (ISB)

Internet Space Builder is a so-called WYSIWYG program which is used to model a VRML object.

![Internet Space Builder](image3)

**Figure 2.9** Internet Space Builder
2.3 VRML Viewers

To view VRML world, either VRML viewer or VRML plug-in for web browser is required. There are many VRML viewers and plug-ins available on the web. In this project, the VRML objects and world were tested with Cortona VRML Client.

2.3.1 Cortona VRML Client

Cortona VRML Client is a plug-in for web browsers to support viewing VRML objects. It is developed by Parallel Graphics. This plug-in supports several popular browsers, such as Microsoft Internet Explorer, Netscape Browser, and Mozilla Firefox. It also supports viewing immediate change of 3D objects, and supports different view mode (Walk, Fly, and Examine).

Figure 2.10  Cortona VRML Client logo

Figure 2.11  Cortona VRML Client 5.1 interface
2.3.2 Other VRML viewers

Beside Cortona VRML Client, there are other VRML viewers available on the web. Here is a table showing the most famous viewers.

<table>
<thead>
<tr>
<th>Viewer</th>
<th>Platform</th>
<th>Script supported</th>
<th>Rendering Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cortona VRML</td>
<td>Windows, Mac OS, PocketPC</td>
<td>VRML Script, Javascript, Java</td>
<td>DirectX, OpenGL</td>
</tr>
<tr>
<td>Client</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Octaga Player</td>
<td>Windows, Linux i386</td>
<td>VRML Script</td>
<td>OpenGL</td>
</tr>
<tr>
<td>Flux Player</td>
<td>Windows</td>
<td>VRML Script, Javascript</td>
<td>OpenGL</td>
</tr>
</tbody>
</table>

Table 2.4 Summary of some VRML viewers
Chapter 3    Analysis

3.1    System Requirements

3.1.1    Hardware

Although VRML can be viewed in almost all the modern computer system, the loading speed, download speed and rendering speed determine the level of attractiveness.

\[
\text{Loading Time} = \text{Download Time} + \text{Processing Time} + \text{Rendering Time}
\]

In normally speaking, the download time depends on the network status and the speed of internet link. Processing time depends on the processor and memory of the system. The rendering time is dependent on the type and memory of the graphic card installed.

So, in order to view the VRML files with acceptable time, the following hardware requirements are recommended:

- Processor: Pentium® 4 1.2 GHz or better
- Memory: 128 MB or higher
- Display resolution: 1024x768 true color
- Graphics card: DirectX 9 compatible
- Network Connection: 1.5M Broadband or above
3.1.2 Software

Since VRML file uses UTF-8 text format, it is very easy to create VRML file with NotePad or other text editors. However, in order to achieve efficient development of 3D world, specific VRML editor was used in this project. VrmlPad is one of the VRML editors, which is suitable to edit VRML files. As mentioned in previous chapter, VRML worlds are viewed with plug-ins in web browser. This project used Cortona VRML Client to test the VRML objects developed.

Other softwares are used to assist for the project development. Here is a list of software requirements:

- Parallel Graphics VrmlPad 2.0
- Parallel Graphics Cortona VRML Client 5.1
- Parallel Graphics Internet Space Builder 3.0
- Adobe Photoshop CS2

![Adobe Photoshop CS2 logo](image)

Figure 3.1 Adobe Photoshop CS2 logo
Chapter 4: Design & Implementation

4.1 Design

Here is the development flow chart of my project.

Figure 4.1 Project development flowchart

The project time period is divided into two parts, before and after development. Before development stage includes data collecting and getting familiarized with VRML. After development stage includes 3D object building, colors & textures mapping, animations adding, objects gathering and optimization.
4.1.1 Data collecting

Before starting the development stage, field work was done in Hong Kong Disneyland at the beginning. A lot of photographs were taken for reference. It is very important to have field work and photo taking, because all the 3D objects and animations were made depending on the photographs taken. If no field work was done, it was very difficult to imagine how the HK Disneyland is. If photographs were not taken, it was very expensive to go to the site again since entrance fee had to be paid.

Figure 4.2 Some photos taken from HK Disneyland.
4.1.2 Getting familiarized with VRML

To build the virtual world with VRML, I had to get familiarized with VRML first. Some reference books and web sites were read, so that I got a sense of what VRML world is and how VRML works. More importantly, this step gave me knowledge to design the virtual world.

4.1.3 Division of the world

Since VRML uses hierarchy nodes structure to describe the 3D objects, it is necessary to divide the actual area into parts in order to build the objects efficiently.

The main buildings of Fantasyland include Sleeping Beauty Castle, Cinderella Carousel, Mad Hatter Tea Cups and Royal Banquet Hall.

The following is the structure of the world:

![Structure chart of the 3D Fantasy world.](image)

For each separated building, division was also undertaken during the development process.
Figure 4.4  Structure chart of Sleeping Beauty Castle

Figure 4.5  Structure chart of Cinderella Carousel
Figure 4.6  Structure chart of Mad Hatter Tea cups

Figure 4.7  Structure chart of Royal Banquet Hall
4.2 Implementation

When building a 3D object, some techniques can be considered to lower the file size.

4.2.1 Reducing the polygons

Once a 3D object is created, the number of polygons used is always as huge as the number of vehicles in Hong Kong. Although the level of details is very high, the file size becomes very large, and the VRML file is very harsh to be delivered over the internet.

In order to reduce the polygon counts of a VRML file, avoid using complex polygons or user-defined polygons since they must largely increase the file size. Do use simple polygons, like triangles and cubes.

4.2.2 Avoid using union operations

In order to minimize the number of vertices and faces of a 3D object, it is recommended to avoid using union operations. When joining two faces together, more vertices may be generated. This will increase the loading time of VRML files. Instead, use extrusion to create complex faces. This function is available in VRML 2.0.

4.2.3 Inlining the world

Reusing the objects may also reduce the file size. VRML defines a node called “Inline” to let the world creator to specify a URL to a file, so that a large VRML file can be separated into small objects saving in separated files.

```
<Group>
  <children>
    <Inline url="world.vrl"/>
  </children>
</Group>
```

**Figure 4.8** Simple usage of Inlining
4.2.4 Using Billboards

In VRML 2.0, Billboard node is defined to make the children of a grouping node always facing the camera. So, a texture mapped object, like trees, can be created without losing its realism and largely increasing the file size.

4.2.5 Code Optimization

In VRML codes, the syntax is always indented with tab characters for easy tracking of codes. However, the indentions occupy a lot of space in a VRML file. This is recommended to delete the indentions before putting the VRML world on to the internet.

Besides, the angle system and color system of VRML always use the numbers between 0 and 1. That means decimal numbers. So, VRML allows the decimal numbers to be typed without leading zero. For example, “0.5” can be typed as “.5”. By doing this zero reduction, the file size will be largely reduced.

Another minor method is to delete the comments in the VRML files.

Here is an example of a VRML file before and after optimization.

```vrml
Children {
  Shape {
    appearance Appearance {
      material Material {
        diffuseColor 0.501961 0.501961 0.501961
        ambientIntensity 1
      }
    }
    geometry IndexedFaceSet { # faces: 56
      convex FALSE
      colorPerVertex FALSE
      color Color {
        color [0.501961 0.501961 0.501961 0.501961 0.501961]
      }
    }
  }
}
```

Figure 4.9 Code sample before optimization.
As shown above, the file is reduced from near 4 MB to 2.2 MB. It is reduced by 44%.
4.2.6 Code Compression

3D objects and world are always having huge size, but it is not practical for an internet user to load a VRML file with 10MB size. Even if the large size file is loaded locally in a computer, it stills take seconds to proceed. So, VRML allows its files to be compressed using gzip.

Gzip is a type of compression tools with free of charge. When a VRML file is compressed into gzip files, the file size will be reduced. Since most of the VRML viewers can automatically unzip the file and extract the objects from the file, it is very useful and convenient to compress the VRML files before putting them onto the internet. Here is an example:

<table>
<thead>
<tr>
<th>名稱</th>
<th>大小</th>
<th>類型</th>
<th>修復日期</th>
</tr>
</thead>
<tbody>
<tr>
<td>castle2</td>
<td>3,979 KB</td>
<td>VRML File</td>
<td>17/4/2007 4:10</td>
</tr>
<tr>
<td>castle2_compressed</td>
<td>519 KB</td>
<td>VRML File</td>
<td>25/4/2007 7:10</td>
</tr>
</tbody>
</table>

Figure 4.12 File size change before and after compression.

After compression, the file size is reduced by 87%.

So, most of the VRML files downloaded from the internet is compressed, so that the files are able to be transmitted within a short time over the link.

4.2.7 Example of file size reduction

Use the Sleeping Beauty Castle as an example. After a series of reduction processes mentioned before, the file size is reduced by 90%.

<table>
<thead>
<tr>
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<th>大小</th>
<th>類型</th>
<th>修復日期</th>
</tr>
</thead>
<tbody>
<tr>
<td>castle2</td>
<td>3,979 KB</td>
<td>VRML File</td>
<td>17/4/2007 4:10</td>
</tr>
<tr>
<td>castle2_reduced</td>
<td>397 KB</td>
<td>VRML File</td>
<td>25/4/2007 7:20</td>
</tr>
</tbody>
</table>

Figure 4.13 File size change before and after reduction processes.
However, the quality of the castle is not affected so much.

**Figure 4.14** The castle object before reduction processes.

**Figure 4.15** The castle object after reduction processes.

As shown above, the difference of two figures is very minor.
Chapter 5: Results

Since the goal of my FYP was to build the HK Disneyland buildings and objects with relatively high level of detail, only the main buildings were finished.

5.1 View of the whole virtual world

Figure 5.1 3D Fantasyland (Entrance view)

Figure 5.2 3D Fantasyland (Entrance crane view)
Figure 5.3 3D Fantasyland (Back side crane view)

Figure 5.4 3D Fantasyland (Back side view)
5.2 Sleeping Beauty Castle

Figure 5.5 Sleeping Beauty Castle (Front view)

Figure 5.6 Sleeping Beauty Castle (Back view)
**Figure 5.7**  Sleeping Beauty Castle (Left side view)

**Figure 5.8**  Sleeping Beauty Castle (Right side view)
**Figure 5.9** Sleeping Beauty Castle (Zoom view 1)

**Figure 5.10** Sleeping Beauty Castle (Zoom view 2)
Figure 5.11  Sleeping Beauty Castle (Zoom view 3)

Figure 5.12  Sleeping Beauty Castle (Zoom view 4)
Figure 5.13  Sleeping Beauty Castle (Zoom view 5)

Figure 5.14  Sleeping Beauty Castle (Zoom view 6)
Figure 5.15  Sleeping Beauty Castle (Zoom view 7)

Figure 5.16  Sleeping Beauty Castle (Zoom view 8)
Figure 5.17  Sleeping Beauty Castle (Zoom view 9)

Figure 5.18  Sleeping Beauty Castle (Zoom view 10)
5.3 Cinderella Carousel

**Figure 5.19** Cinderella Carousel (Top down view)

**Figure 5.20** Cinderella Carousel (Front view)
Figure 5.21  Cinderella Carousel (Main part front view)

Figure 5.22  Cinderella Carousel (Main part bottom up view)
Cinderella Carousel animations:

**Figure 5.23**  Continual screenshots of Cinderella Carousel animations
5.4 Mad Hatter Tea Cups

Figure 5.24 Mad Hatter Tea Cups (Top down view)

Figure 5.25 Mad Hatter Tea Cups (Front view)
Figure 5.26  Mad Hatter Tea Cups (Bottom up view)

Figure 5.27  Mad Hatter Tea Cups (Zoom View 1)
**Figure 5.28**  Mad Hatter Tea Cups (Zoom view 2)

**Figure 5.29**  Mad Hatter Tea Cups (Zoom view 3)
Mad Hatter Tea Cups Animations:

Shot 1

Shot 2

Shot 3

Shot 4

Shot 5

Shot 6

Figure 5.30  Continual screenshots of Mad Hatter Tea Cups animations
5.5 Royal Banquet Hall

Figure 5.31 Royal Banquet Hall (Front view)

Figure 5.32 Royal Banquet Hall (Top down view)
**Figure 5.33**  Royal Banquet Hall (Side view 1)

**Figure 5.34**  Royal Banquet Hall (Side view 2)
Figure 5.35  Royal Banquet Hall (Zoom view 1)

Figure 5.36  Royal Banquet Hall (Zoom view 2)
Figure 5.37  Royal Banquet Hall (Zoom view 3)

Figure 5.38  Royal Banquet Hall (Zoom view 4)
5.6 Others

**Figure 5.39** Clock Tower and a shop (View 1)

**Figure 5.40** Clock Tower and a shop (View 2)
Figure 5.41  Clock Tower and a shop (View 3)

Figure 5.42  Clock Tower and a shop (View 4)
Chapter 6: Discussion

6.1 Further Development

In the past years, 3D virtual worlds of Hong Kong International Airports, Ocean Park and Hong Kong Islands were developed in a relatively large area. Since my project was to build detailed objects instead of rough objects, some buildings of Fantasyland still have not been done yet. For example, Dumbo the Flying Elephant, Mickey’s PhilharMagic, Fantasyland Train Station, Fantasy Gardens, etc. These buildings are all having detailed and irregular decorations. Therefore, in order to have further development on Fantasyland, more advanced modeling softwares are recommended to be used instead of just using VrmlPad.

Besides, Adventureland of HK Disneyland was not yet covered in all the FYPs this year, so there is a great freedom to develop the Disneyland further more and detailed.

6.2 Contributions

I had successfully developed the main buildings of the Fantasyland of Hong Kong Disneyland. Compared with previous projects, I had tried my best to make the buildings much more detailed and realistic. Optimization techniques were also considered in the project. This project can give the viewer information about the overview of the inside buildings of Disneyland.
6.3 Other uses of 3D web

A normal VRML world can be further developed to become a multi-user 3D world. There is now having 3D web space on the internet, so that the logged-in users can talk and communicate with each other. They can create their own characters, or called avatars, to represent themselves. They can also play 3D games in the virtual space together. Blaxxun.com is an example of such multi-user 3D space provider.
Chapter 7: Conclusion

It is expected to develop a virtual world of Fantasyland of Hong Kong Disneyland with VRML. The main parts of the Fantasyland were developed, where still have a few parts not yet finished. Among the parts developed, some animations are added to them in order to have more realistic feels. The buildings were developed with great details, so that they look more realistic.

To view the VRML worlds, VRML viewer has to be installed, or VRML plugin has to be installed for web browser. To edit the VRML files, a notepad is sufficient to modify the content.

This FYP gives me opportunity to learn the VRML programming and the knowledge of 3D modeling. This encouraged me to strive for learning interest on 3D modeling.
References

1. Parallel Graphics
   http://www.parallelgraphics.com/

   http://archone.tamu.edu/tlarsen/ends370/index/CH2.HTM

3. Tricks to Optimize Your VRML Worlds for the Web

4. The VRMLworks
   http://vrmlworks.crispen.org/

5. Blaxxun
   http://www.blaxxun.com/

6. The Virtual Reality Modeling Language

7. VRML 1.0C Specification
   http://www.web3d.org/x3d/specifications/vrml/VRML1.0/index.html

   http://en.wikipedia.org/wiki/VRML

9. VRML Home @ Lighthouse 3D
   http://www.lighthouse3d.com/vrml/index.shtml

10. Octaga
    http://www.octaga.com/

11. Media Machines – Flux Studio
    http://www.mediamachines.com/
Glossary

ASCII

ASCII stands for American Standard Code for Information Interchange. It is a character encoding based on the English alphabet.

Flash

Flash refers to the multimedia program created with Adobe Flash Professional. Flash player has to be installed for viewing Flash objects with web browser.

Gzip

Gzip stands for GNU zip which is a software application used for compression.

Hyperlink

Hyperlink is a reference of a location on the web.

PDF

PDF stands for Portable Document Format. It is used for representing two-dimensional documents in fixed layout document format.

Plug-in

Plug-in is a computer program that interacts with a main application to provide specific functions.

UTF-8

UTF-8 stands for 8-bit Unicode Transformation Format. It is a variable-length character encoding for Unicode.

VRML

VRML stands for Virtual Reality Modeling Language, which is a standard file format for representing 3D interactive vector graphics.