

Using VRML to Build a Virtual Reality Campus Environment

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ABSTRACT

Virtual reality has been involved in a wide range of academic and commercial applications. It can give users a natural feeling of the environment by creating realistic virtual worlds. Since its first release in 1994, the VRML (Virtual Reality Modeling Language) is widely used today for simulations, scientific visualizations and different architectural models on the internet.

In this paper we discuss the design of a virtual reality model of University of Sargodha, Pakistan. We have also discussed the issues faced during the development of our model. Finally we have presented an analysis of applicability of VRML in such applications.

KEYWORDS: Multimedia, Virtual Reality, VRML, Virtual Campus, World Wide Web.

1. Introduction

VRML is a scene description language which describes the behaviour of the 3D world and defines how a user will navigate in the 3D world. It is used widely on the web due to its simplicity and portability. The text format of VRML quickly allows the creation of virtual worlds having 3D shapes, lighting, sound effects, fog effects and even animations. VRML uses a Cartesian coordinate system to create 3D objects. The VRML file comes with *.wrl extension. A VRML compatible browser is needed to display virtual worlds. The user can watch the animated virtual world or even move in the three dimensional space. VRML 2.0 provides support to animation, sound, java script and allows creation of dynamic 3D scenes. The 3D virtual tour of University of Sargodha campus allows users (faculty members, students, new comers, parents etc.) to walk into the campus and familiarize themselves with various departments and buildings. They can enter in virtual classrooms and computer labs without actually being there. Extensible 3D (X3D) is the successor to VRML. It provides several improvements in VRML but it is relatively complex than VRML 2.0.

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All the buildings in the virtual campus are modeled like original buildings with the help of textures, lighting and camera views. The various buildings include the Computer Science and IT department, the Pharmacy department, the Administration hall, and the Psychology department. The system also detects and controls the collisions occurring in the virtual environment.

Although users can freely walk, navigate and interact with the system, yet they are not allowed to do unrealistic things like walking through the walls and ceilings etc. A proper mechanism is followed to avoid such things in the virtual environment. Different camera views are set at different locations to provide different views of a scene. Each view provides a different angle of the scene in order to present a natural environment. Our application has not been completed yet but many departments and main building are available for sightseeing.

The paper is organized as follows. Section 2 provides an overview of VRML. The design of virtual campus is provided in Section 3. A brief description of related work is mentioned in Section 4. Section 5 is dedicated to concluding remarks.

2. An Overview of VRML

VRML is largely used to present 3D graphics on web. VRML file is a simple text file which contains objects and their attributes and specifies the structure and organization of virtual worlds. VRML can also be used for animation sequences. The previous version, VRML 1.0 adopted in 1995 builds static and non interactive worlds. The current version of VRML is VRML 97. It is a standardized version of VRML 2.0 specifications. VRML supports many technologies in order to create functional and interactive 3D worlds. Some of these features include special nodes (like background, fog, billboard, anchor etc.), animations, scripting, sound, movies etc. The file size of VRML worlds is often less. Simple text-editors are often used to construct virtual worlds. However, world builders and shape generators are also used to create virtual worlds. VRML is case sensitive so using upper and lower case characters does make sense.

A typical VRML file contains the file header, nodes, fields and their values. Without the file header the browser cannot recognize the file as VRML file. The first line in any VRML

file must be the file header (i.e. `#VRML V2.0 utf8`). The `#` symbol denotes a comment line. The VRML keyword suggests that the file is a VRML file and the code confirms the version 2.0 specification. The last part of header line explains that the file uses international UTF-8 character set.

The nodes are regarded as a basic building block of VRML file [1]. They describe the content of a scene. A typical node consists of a node type (i.e. Shape, Transform, Group, Appearance, Navigation, Interpolators etc.) and a set of curly braces which contains the body of the node. Shape node is the most important node as it creates different shapes. Primitive shapes are standard building blocks such as Box, Cone, Cylinder, Sphere and text. The attributes of any node are described by Fields. Every Field has a name, a data type and a default value. A simple box is drawn by the following code.

```
#VRML V2.0 utf8
# 3D Cylinder
Shape {
  appearance Appearance {
    material Material {
      diffuseColor 1.0 0.0 0.0
    }
  }
  geometry Cylinder{
    height 2.2
    radius 1.5
  }
}
```

Here Shape node is used to draw a cylinder. The Shape node has two fields namely appearance and geometry. The values for these two fields are Appearance and Geometry node respectively. Here Appearance node has its own field called material with a value as material node. Figure 1 shows a simple text example using VRML.



Figure 1: A simple text example using VRML.

There is variety of nodes used to define simple and complex geometry. But primitives require much less data and have

faster download times than their polygonal equivalents (i.e. index face sets). The default field values are used when no value is specified. All the shapes are built in a coordinate system. By default, all shapes are built in the centre of the world. The colors in VRML are specified in RGB color space. Each color (red, green and blue) is given a value between 0 and 1.

Texture mapping is mostly used to make a realistic impression of different shapes. It binds the image on the specific shape. VRML supports image formats like GIF, JPEG and PNG. Additionally, movie file (MPEG-1) is also used as a texture.

```
#VRML V2.0 utf8
Shape {
  appearance Appearance {
    material Material { }
    texture ImageTexture {url "image1.jpg"}
  }
  geometry Cylinder {
    height 2.7
    side TRUE
    bottom TRUE
  }
}}
```

The Transform node is used to create a new coordinate system relative to the parent coordinate system. With Transform node, we can do translation, rotation and scaling. Figure 2 shows an example of different shapes with background.

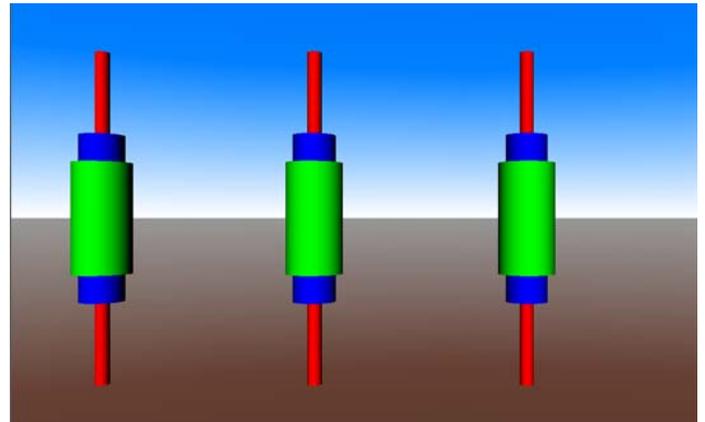


Figure 2: Different shapes with background.

To build complex virtual worlds many Shape nodes are required. Moreover not all the objects are of regular shape. IndexedFaceSet node is widely used to build complex arbitrary shapes. Other nodes used for this purpose are PointSet node (list of 3D coordinates determining the location of each point), IndexedLineSet node (an extension

of PointSet node specifying not only the points but also the instructions on how to join those points to create lines).

Group nodes are used to group various shapes in order to compose complex shapes and let them treated as a single entity. There are eight types of grouping nodes (i.e. Billboard, Transform, Anchor, Inline, Transform etc) in VRML. The Group node creates a basic group where every child node in the group is displayed. We can also define specific name for any node. This is useful in situations when there are several shapes having same geometry or appearance which have to be used several times in the code. Instead, we can define a name for the first occurrence of the node and later use the same name in a different context. A name is given to a node by using DEF keyword. The USE keyword uses a previously named node. Using named nodes provides several benefit such as reduce file size, decreasing complexity, speeds browser processing and enabling quick changes to the code.

There are several nodes provided by VRML to define the environment surrounding the basic shapes in the scene. One such feature is controlling the lighting in the scene. By default, a light source is placed in the scene. Light sources can be added to provide a more realistic look to the scene. In VRML there are three different types of lights namely point lights, directional lights and spot lights. There are some common fields (on, intensity, ambient intensity, color) shared by all light sources. Point lights and spot lights also have a radius, attenuation and location. Whereas directional lights and spot lights have directions. Similarly background can also be added to provide a context. Black is the default background color for VRML worlds. A Background node is used to create different backgrounds. To include more realism in the scene, fog is used to create hazy worlds. It is also a smart trick to decrease the development time as fewer things are needed to be created. The typical color of fog is white, although different colors are also possible.

Sound effects are added by using Sound node. Sounds can be continuous or triggered by user's actions. Finally animation is the feature used to make shapes move, blink, scale, rotate and many more. Animations are created by making animation circuits where each node is a component of the animation circuit and messages are sent between nodes (events). To complete an animation circuit a node which sends messages are connected with node which receives messages. These nodes are named by using DEF keyword.

3. Design and Implementation of Virtual Campus

The whole virtual tour is built using VRML 97. A number of objects have been designed to be used in complex scenes. The application provides sufficient information to new students, existing students, parents, and any other user. The tour consists of three dimensional models of Computer

Science and IT Department, Department of Pharmacy, Administration block of the University and Department of Psychology. The dimensions of different buildings have been obtained to make an accurate representation of these buildings. Figure 3 shows a view of Computer lab in CS & IT department.



Figure 3: A View of a Computer Lab.

Textures are used on building structures to provide a same look and feel as real buildings. Collision detection is used to avoid unrealistic movements. Trees are constructed by using set of billboard nodes. Wooden textures are used for stem. To add more realism digital photos of selected trees in the campus are used. Primitive cylinder shape is used to build electric poles and for glob sphere is used. Different camera views are set at different locations to provide different views of a scene. Each view provides a different angle to the user. Different level of details has been employed to optimize the amount of details rendered in the scene. Figure 4 shows the exterior view of Computer Science and IT department.



Figure 4: Exterior view of Computer Science and IT Department.

The construction of virtual campus is never ending as various departments are constantly expanded and renovated. Since efficiency is a major issue, the whole virtual world consists of many parallel smaller virtual worlds. Each department has its on model on its webpage. Figure 5 shows the virtual tour's interface of CS & IT department.

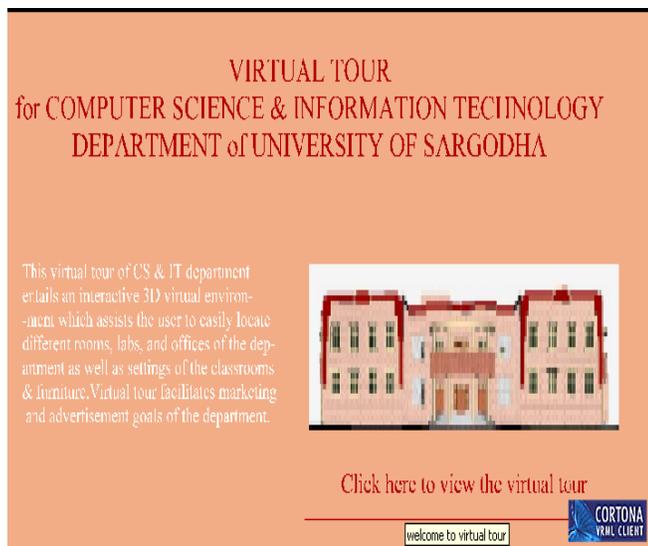


Figure 5: Virtual Tour's Interface of CS & IT Department.

In each department the lecture rooms, offices and labs have been built separately and Inline node is used to integrate them so that the users are able to navigate among different scenes through already set viewpoints. Use of DEF and USE have also reduced the number of files to be inline and decreased the file size and allows reusing different models in the scene. Figure 6 shows a view of library in pharmacy department.



Figure 6: Library of Pharmacy Department.

All the lecture rooms, offices and labs are furnished with main objects (i.e. chairs, tables, whiteboards etc.). A view of a lecture room in CS & IT department is shown in figure 7.

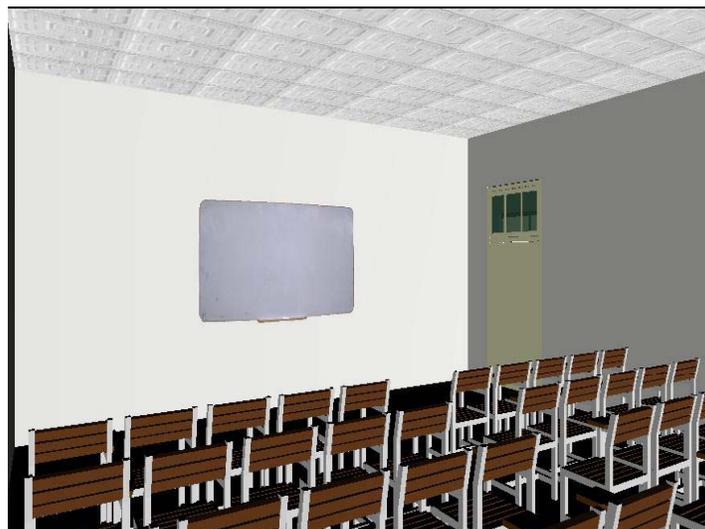


Figure 7: A Lecture room in Chemistry Department.

4. Related Work

In recent years many virtual campuses have been built. A virtual model for Avcilar campus of Istanbul University has been built [2]. A Nanyang technological university virtual campus is given in [3]. Similarly work has been done on *Virtual reality classroom strategies for creating social presence* for delivering course materials via virtual environment [4]. [5] Presents a case study in medical education for building virtual reality environments for distance education on the web. The paper investigates the role of virtual reality and web technologies in the field of distance education and reflects the educational benefits arising from using virtual reality technology in web-based medical simulations [5].

Hui-jun Ren and Da-kun Zhang [6] has discussed the studied plans to build virtualized scenes based on the virtual reality and java technology. Similarly virtual reality is used in the field of chemistry to utilize the power of web and virtual reality. VRLUP [7] and LAB 3D [8] deals with safety and biochemistry issues respectively. CSU Chemlab [9] deals with hygiene issues.

5. Discussion and Conclusion

Virtual tours provide a simulation of real environment. It allows the users to view their desired locations without their physical presence. They can get information and experience which may not be possible. This can also be viewed as an advertisement and marketing strategy. The paper presents our implementation of virtual campus as an application of virtual reality in education. The virtual world has been built using VRML which has a strong capability of creating

dynamic 3D worlds and is widely used due to its simplicity, portability and flexibility. The tour provides general information about interior and exterior structure of various departmental buildings. The buildings in the virtual campus have been modeled like original buildings with the help of textures, lighting and camera views. The users can freely walk, navigate and interact with the system, yet they are not allowed to do unrealistic things like walking through the walls etc. VRML still keeps on developing and is succeeded by X3D.

There are some limitations which we faced during the development. A high speed internet connection is required to view the full world. The tour will be constantly expanding to incorporate more features and functionality of VRML. The VRML files have been compressed but still the size of models are not optimum. In future, we want to expand the tour and include the simulations of class teaching environment which will help to study in this virtual environment. A virtual campus study environment will be more attractive and expressive and the users can learn with the help of interactive material.

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