

Establishing 3D Virtual Campus Using Open Source Software

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ABSTRACT: The use of the Internet has become popular in recent years. Abundant spatial information such as electronic maps are presented in the form of web pages, however, most of the information is shown as two-dimensional instead of three-dimensional web pages. Therefore, the objective of this study is to implement a web-based 3D virtual campus using open source software. The Google O3D is used to create interactive 3D graphics application that runs in a web browser. By integrating 3D models created using Google SketchUp, spatial information of features, and software tools, this research demonstrates that O3D is a good tool for 3D simulation and modeling, which makes it suitable for building a 3D navigation system for virtual campus.

1. INTRODUCTION AND MOTIVATION

The history of the Internet started from original static web pages which were generated by HTML (HyperText Markup Language), and then the CSS (Cascading Style Sheets) introduced so that it can separate the content and the style of web pages. With the AJAX (Asynchronous JavaScript and XML) technology developing, the original static web pages transformed into dynamic web pages. Though the technologies of web pages have grown up in recently years, most of web pages are shown as two-dimensional content instead of three-dimensional web pages. Furthermore, the spatial information which is demonstrated in 3D platform is much richer than the spatial information demonstrated in 2D platform. As Figure1 and Figure2 illustrated, Figure1 which is part of 2D satellite image in Taipei city can only show the horizontal spatial information, but Figure2 can show more spatial information than the Figure1's, for example, we can recognize the location of the image in Figure2 because of 101 3D building, but it is a bit of hard to interpret the location of image in Figure1. Therefore, the objective of this research is to implement 3D virtual campus navigating spatial information system. Firstly, we use Google SketchUp software to create 3D models, and then convert it to COLLADA (COLLABorative Design Activity) 3D format. Finally, we put it in web pages and create the interactive applications that enable web browsers to query the information of 3D buildings by using Google O3D API.



Figure 1: 2D satellite image in Taipei city (Google Earth)



Figure 2: 3D satellite image in Taipei city (Google Earth)

2. TECHNOLOGY OVERVIEW

2.1 HTML

HTML stands for Hyper Text Markup Language, so that it is a markup language and not a programming language. A markup language is a set of markup tags called HTML tags, which describe the web pages. Figure 3 can demonstrate the HTML tags and architecture of HTML, the HTML tags are keywords surrounded by angle brackets like <html>, and it normally comes in pairs like <p> and </p>. The first tag in a pair is the start tag, and the second tag is the end tag. A HTML file contains two basic tags like <html> and <body>. The <html> and </html> tags describe that the file is in the form of web pages; the <body> and </body> tags describe the content of the web pages. Therefore, if we want to change the style of the web pages, we can add some tags like <p>, <h1> and tags to make the web pages lively. The text between <p> and </p> is displaying as a paragraph font style; the text between <h1> and </h1> is displaying as a heading font style and the text between and is displaying as bold font style (<http://www.w3schools.com>).

```
<html>
<body>
<p>This is a HTML document example</p>
</body>
</html>
```

Figure 3: Basic HTML tags

2.2 JavaScript

JavaScript is a scripting language designed to add interactivity to HTML web pages, and a scripting language is lightweight programming language. JavaScript is usually embedded directly into HTML pages and it is an interpreted language that scripts execute without preliminary compilation. There are many advantages that JavaScript works. Firstly, we can use JavaScript which is a scripting language with a simple syntax as a programming tool when designing the HTML, so that web designers can put some JavaScript codes in HTML web pages. Secondly, JavaScript can be used to create the event functions, which enable web browsers to do some interactive applications in the web pages, like when a web browser click on button which is an HTML tag. Thirdly, DOM (Document Object Model) which is the W3C standard allows scripting languages like JavaScript to access or update the content of HTML web pages, for example, we can use JavaScript to change the HTML tags like image, table, and text. Fourthly, JavaScript can be used to check the validation of form data so that it will save time for server to deal with the extra processing. Finally, JavaScript is safe to be used, and it is impossible for JavaScript to change the data saved in server (<http://www.w3schools.com>).

2.3 Google O3D

O3D is Google's open source project which is packing with a plug-in, and its interactive 3D graphic application that runs in a web browser is created by JavaScript API. O3D can be used in many application area including 3D games, 3D animation, advertisements and 3D virtual reality. There are many advantages using O3D. Firstly, O3D provides excellent engineer that accelerates GPU (Graphic Processing Unit) efficiency. And then O3D can be used in variety of web browser platforms including Firefox, Safari, Google Chrome, and Internet Explorer. Thirdly, O3D can also be used in different OS (Operate System) platforms. Finally, O3D can be supported in most of graphic cards. (<http://code.google.com/intl/zh-TW/apis/o3d/docs/techoverview.html>).

2.4 Google O3D API

The O3D API is developed by JavaScript so that the developers who use O3D API should familiar with JavaScript and should have some background in 3D graphics. Developers can create interactive functions which are done via JavaScript calls to O3D API modules (<http://code.google.com/intl/zh-TW/apis/o3d/docs/techoverview.html>).

2.5 Google SketchUp

SketchUp is Google's 3D modeling software, which can create 3D models easily. SketchUp can be used in many application areas including architectural, civil, and mechanical engineers as well as filmmakers, game developers, and related professors. The advantages of SketchUp are that it can not only be used easily but also the 3D models created by SketchUp can be placed within Google Earth software (<http://en.wikipedia.org/wiki/SketchUp>).

3. RESEARCH AND DEVELOPMENT PROCESS

The process of this research starts from creating the 3D models, and then creates interactive application in web pages. The details of process are followings :

3.1 Create 3D Buildings in Campus Using SketchUp Software

We can create 3D models using SkethUp software easily, and then we take them as test data in this research. After creating the 3D models, we use each side of the building's image as the 3D model's texture. The step of creating 3D models are followings :

- 3.1.1 Select the location of the building's satellite image using Google Earth software
- 3.1.2 Catch the satellite image using Google SketchUp software
- 3.1.3 Take each side of building's image as 3D model's texture

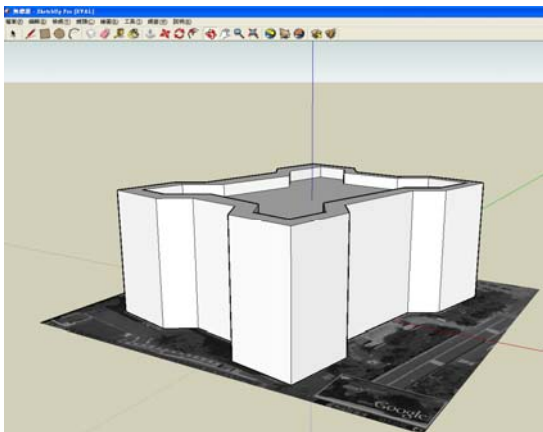


Figure 4: 3D model created by Google SketchUp



Figure 5: Different sides of 3D model's images

3.2 Convert the Format of 3D Models to The Format Which O3D Can Be Used

Figure6 demonstrates that the 3D model format which O3D supports is COLLADA (COLLABorative Design Activity) 3D format. COLLADA is a file for establishing an interchange file for interactive 3D applications, and it usually identified with a .dae (digital asset exchange) filename extension. O3D provides a COLLADA Converter, which can convert COLLADA 3D file to JSON-based content archive (.tar.gz). Therefore, we can use O3D API to load the 3D models in JSON-based content archive format into web pages.

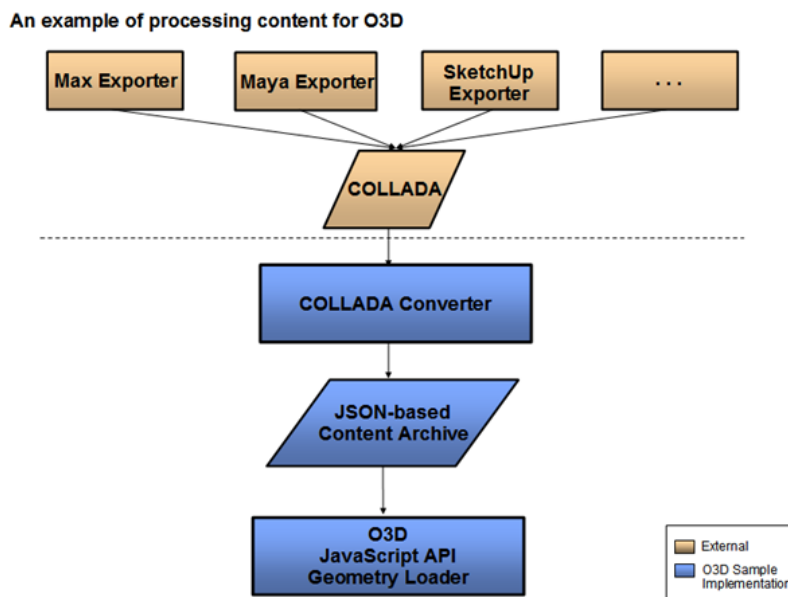


Figure 6: Imported content of O3D model (<http://code.google.com/intl/zh-TW/apis/o3d/docs/techoverview.html>)

3.3 Create Interactive Applications Using Google O3D API

We can use JavaScript to include the library of O3D and call the modules. Figure7 demonstrates the workflow of O3D application. Firstly, JavaScript API can be recompiled to C/C++ code which is in OpenGL and Direct3D standards by O3D plug-in, and then the C/C++ code will accelerate the efficiency of GPU. Therefore, we can create interactive application like placing the 3D models in web pages, controlling the size of 3D models, changing the texture of 3D models.

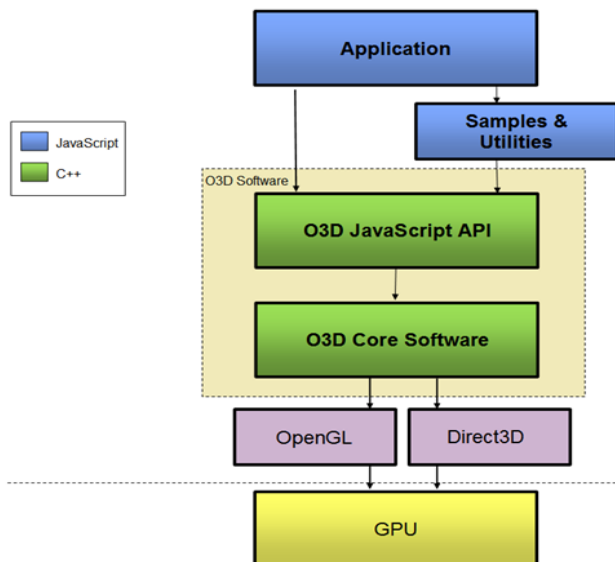


Figure 7: Arctecture of O3D (<http://code.google.com/intl/zh-TW/apis/o3d/docs/techoverview.html>)

3.4 Create Database to Save the Data of 3D Models Using ODBC Technology

The architecture of this system can be divided into back-end and front-end. The back-end is composed of database for storing attribute information like the name of 3D models so that we can manage the back-end data by using DBMS (DataBase Management System). The front-end is displaying as HTML web pages. ODBC (Open DataBase Connectivity) is a standard software interface for accessing DBMS. Therefore, ODBC can be used to retrieve the back-end data and display them in the front-end web pages.

3.5 Demonstrate the 3D buildings in the form of web pages

The result of this research will present in the form of web pages, we will use JavaScript to call O3D's modules, which enable us to place the 3D models in the HTML web pages and create interactive applications. Besides, we will also use CSS (Cascading Style Sheets) to make the style of the web pages consistent.

4. RESEARCH RESULTS

The result of this research is displaying as web pages, which can be divided into two parts. The first part is displaying as spatial information, and the second part is displaying as attribute information. As illustrated in Figure8, the left side of this figure shows the spatial information of the 3D models like the shape, size, texture, and the location of the 3D models; the right side of this figure shows the attribute information like the name, image, and the note of the 3D models.

As Figure8 illustrated, the O3D scene on the left side of the web page is created by Google, and we import it using Google O3D API, and the right side of the web page is created by using HTML tags.

We create keyboard event applications that can change the size of 3D models, of which web browsers want to query the attribute information, as illustrated in Figure9. Web browsers can enter different keyboard buttons to get the attribute information of 3D models or type the name of 3D models to retrieve the information. In addition to the attribute information we provide above, we also provide related URL links about the 3D models, as Figure10 illustrated.



Figure 8: Initial web page of O3D

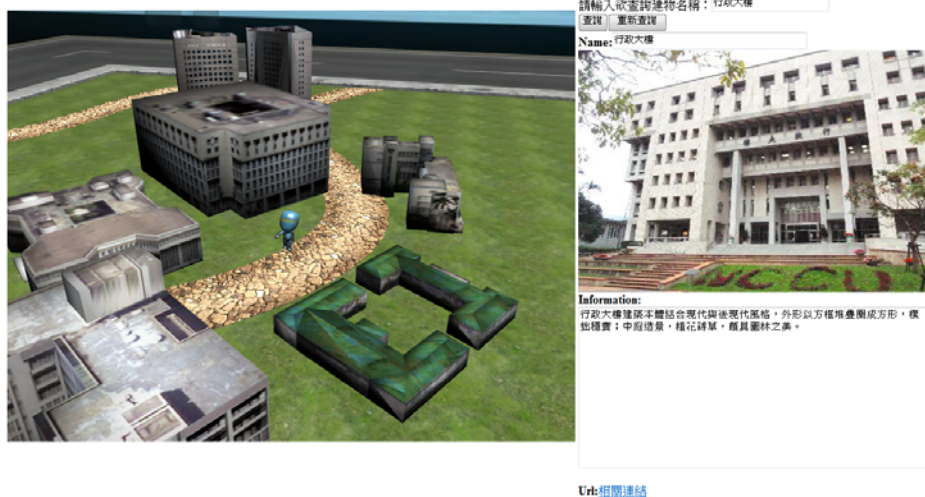


Figure 9: Querying the information of 3D model

We import the 3D Google character created by Google so that web browsers can control the directions and movements of the Google character by keyboards. The interface we create allows web browsers zoom in/out the view of 3D models, so that web browsers will be able to look at the details of the 3D models. Figure11 demonstrates that we can control the 3D Google character to view different sides and details of 3D models.

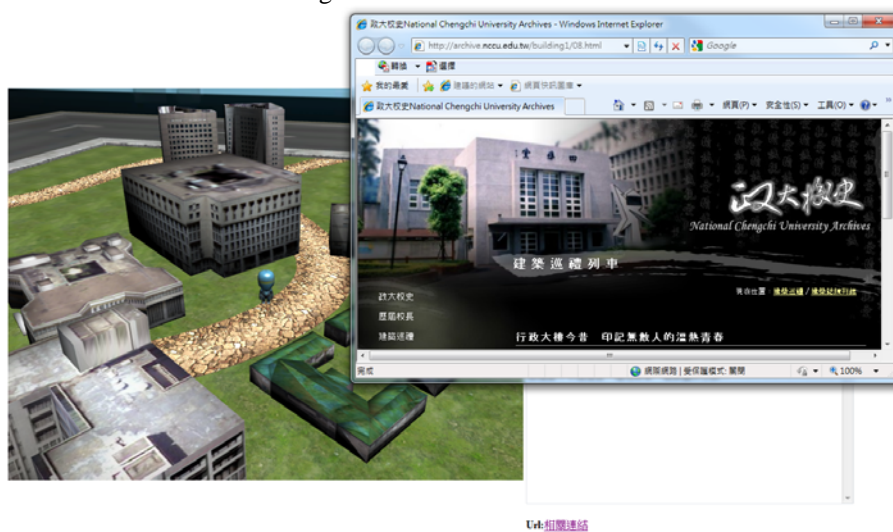


Figure 10: Related URL of 3D model



Figure 11: Zoom in/out the scene of 3D model

5. CONCLUSION AND RECOMMENDATIONS

The objective of this research is to implement 3D virtual campus navigation system using open source. We use Google SketchUp to create the 3D models and use Google O3D API to create the interactive applications. We also create database to manage the attribute information of 3D models. The result of research is displaying in web pages. To summarize the research above, the conclusions and suggestions are followings :

1. 3D platform can show much more information than 2D platform so that there are more and more applications like 3D urban planning and 3D disaster prevention simulations are all displaying in 3D platform. Moreover, with the high popularity of internet in recently years, there are more and more spatial information systems based on web pages. Therefore, it is meaningful to create web-based 3D spatial information system.
2. The 3D virtual campus navigation created by using Google O3D API and Google SketchUp can present not only the 2D attribute information of 3D models but also the 3D spatial information of 3D models.
3. The Google O3D API that we use to create interactive applications is based on JavaScript, which is flexible in the development of web pages, including keyboard, mouse and other events.
4. Though we can use Google O3D API to embed the 3D models into web pages easily, the number of 3D models in the web pages will affect the performance of browsing the web pages. The level of graphic card which web browser use will also affect the performance of browsing the web pages.

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