WEB BASED 3D TERRAIN VISUALIZATION USING GAME ENGINE

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ABSTRACT. Recently, most of the Geographic Information System (GIS) applications now are moving toward into 3D environment where some of geo-browsers such as Google Map and Microsoft Virtual Earth are ready with this capability. Terrain visualization is the main part of these system. The aim of this paper is to discuss on the development of online 3D terrain visualization using unity 3D game engine. The process involved with the data preparation of terrain data (DEM) which need to be converted into HDR (header) and FLT (float) format. The terrain data then is imported into unity 3D for generating 3D terrain data. These data were pre-overlaid with the images data. Both types of data is then export into web player format using unity 3D. The web based development were design and draft suite to the applications and publish into the web server. The users can interact with this system in 3D environment terrains with the capability of walk through, view from different angle, first and third person view, and overlaid mode view. It therefore gives benefits to potential visitors, decision makers and planners to explore and gain experience the 3D environment of terrains virtually.

Keywords: 3D terrain, satellite image, game engine, unity 3D

INTRODUCTION

Map is a drawing representation of a flat surface of the whole or a part of an area and it also served to give out information's (MapsofIndia.com, 2012). It have been used for centuries as guides to find a locations, military actions and geographic supports. Normally, the information on map is often display information in two dimensional (2D) format by using colours, lines, and legends which sometimes hard to interpret by normal user who do not have knowledge on reading a map. Nevertheless, with the emerging and rapidly growth of the new technology, 2D maps can now be view in 2.5 dimensions (2.5D) which uses 45 degree view to simulate the data as it is showing in 3D view but still 2.5D. The view still limited to viewing object in fully 3D environment. This types of viewing is still not popular and less known by the user. All of these scenario help to motivate the present research in developing a tool for online 3D terrain visualization, this paper is proposing on creating 3D terrain view which would be able to simulate real world data more accurately in 3D terrain. The development of the system utilize several software's such as ArcGIS, unity 3D and Macromedia Dreamweaver. The process started with the data preparation inform of Digital Elevation Model (DEM)

data of terrain in any format either raster or vector from any place. These data is then need to be processed using ArcGIS software where it will be converted into FLT and HDR format. Once converted, the terrain were constructed inside unity 3D and 3D visualization of the terrain were appeared. Once the terrain have been generated, it's included the terrain function such as camera view, which enable the user to view in six different views (five perspective view and one orthographic view) together with the real coordinate system. After the terrain ready with pre-overlaid satellite imagery, it is exported into web based format (unity 3D). Then the terrain is imported into unity 3D web player format. Then the next stage was formatting this data using Macromedia Dreamweaver for better viewing in web based system. Users can interact with the system by using several functions such as walk through, jump and slide. The interesting about this Web Based Terrain Visualization system is that the user can access it from anywhere and at any time without paying any fee. What they need to do is only install the unity 3D viewer (software) which are freely available from the internet.

RELATED WORKS

A lot of research have been done on online 3D terrain visualization around the world. For example Ruzinoor, Shariff, Pradhan, Mahmud, & Rahim (2012) have done extensive study on online 3D terrain visualization. Some of their study included finding the best GIS software for online 3D terrain visualization (Ruzinoor, Abdul Rashid, & Ahmad Rodzi, 2009), finding the best web servers for online 3D terrain visualization (Ruzinoor, Shariff, & Mahmud, 2009b), finding the effectiveness of different satellite image for overlaying with 3D terrain (Ruzinoor, Shariff, & Mahmud, 2009a), finding the best contour line intervals for online 3D terrain visualization (Ruzinoor, Shariff, Pradhan, Ahmad, & Rahim, 2010), and finding the best rendering technique for 3D terrain visualization (Ruzínoor, Shariff, Mahmud, & Pradhan, 2012). In other hand, the research conducted by Detweiler (2009) explain on developing a techniques to use 3D terrain surface measurements in vehicular simulations. Furthermore, Celio, Ott, Sirén, & Grêt-Regamey (2015) have utilising Crytek Cryengine 3.4.5 for creating 3D visualizations based on the land use modelling output. This game engine allow to establish the connection between geo-reference model and 3D visualizations output. While Aziz, Chang, Esche, & Chassapis (2014) using a commercially available 3D game engine in creating a new framework for authoring Virtual Environments (VEs) for mechanical assembly training. Vergauwen, Pollefey, & Gool (2001) found that the 3D terrain also can be used for space studies where in their research, the data from Mars uses to create a 3D terrain. Trenholme & Smith (2008) has done a report on overview several game engine such as CryEngine, id Tech 3 Engine, id Tech 4 Engine, Jupiter Extended (EX), Source Engine, and Unreal Engine 2. Based on their report, all of the game engine discussed in their report are suitable for developing non-game applications in VEs. Game engines are toolkits to ease the progression of video games which usually packed with set of tools needed in the design and coding stages (Navarro, Pradilla, & Rios, 2012). A study by Humbert (2011) involved techniques on visualizing a town scale model dating from the 19th century by using a game engine. In another major study, Jie (2011) found that game engine also can be applied for scene optimization skills and problems of mobile phone based. Besides that, research on utilizing a 3D game engine to develop a virtual design review system done by Shiratuddin & Thabet (2011) stated that the strength of game engine in different criteria: real-time rendering, interactivity, lighting, real-time walk through, collision detection and multi-participatory feature. Wang, Mao, Zheng, Gong, Li & Chen (2010) has done a report on discovering new method of virtual reality based on game engine which is unity 3D. Other than animated meshes, shadows, particle systems and advanced lighting, unity 3D also support individual operations to create sparks, rain, dust trails, and anything that people can imagine.

WEB BASED 3D TERRAIN VISUALIZATION USING GAME ENGINE

The development of web based 3D terrain visualization using unity 3D game engine can be divided into several stages which were data preparation, image preparation, construction of 3D terrains, generated terrain using unity 3D, overlaid terrain, web based development, and deployment. All the stages were related to each other where need to be complete before can proceed to the next stage.

Data preparation

Data preparation for this system development is performed by using the ArcGIS software. The process started by adding the SHP files of the selected terrain data (contour area) into project in ArcGIS. Every selected area has a different project file. The data is then converting into Triangular Irregular Network (TIN) layer based on the height of the selected contour area. The DEM data format that can only be accepted by unity 3D was HDR (header) with FLT (float) data format. The projection used for this data was the Rectified Skew Ortho-mophic (RSO) Peninsular Malaysia.

Image preparation

In this stage, the image of the data should be in raster format. The image data could be the land use map, aerial photograph data, and satellite image. For this project the land use map and satellite image data were used. The projection used for this data is similar as the terrain data (DEM format) which is RSO format. In order to be fitted with the terrain data, the land use map and satellite image data need to be clipped so that it covers the same area as the terrain data. This is where the accuracy of the data is important. If the clipping is not carried out correctly or in the wrong sequence, the accuracy of the resulting data will be lower. But if it is done correctly, the data will maintain its high quality. The PCI Geomatica software is used to clip the image data into the same area as the terrain data. The four coordinates for clipping the image data is similar as coordinates in terrain data. The process started with opening the whole of image data. Then the process continued with inserting four coordinates to be clipped. Setting the destination of output files and file format also need to be done. Finally the data is clipped based on the four coordinates set before and was saved in TIFF format.

Construction of 3D terrain

The process of generating the terrains begin with loading the terrain data which is in DEM format (FLT and HDR) into unity 3D. By using the custom script that was added into unity 3D, the scripts is then reads the float file (FLT) and its header (HDR) to generate a terrain in unity 3D. The terrain generated from this technique would have the information of the terrain data such as location data x, y and z. The z value represent the height data of the place in meter. This height data is based on the location of avatar be pointed exactly on the terrain surface. The construction of the terrain inside unity 3D allow a much easier method of construction by applying add on or plug-in which are available inside unity 3D and unity 3D asset.

Generate terrains using unity 3D

In this stage, the plug-in of the unity 3D need to be inserted into the 3D terrain. This plug-in need to be manipulated and set for the purpose of viewing the 3D terrain. Its implementation were allow the user to controls of the viewing of the terrain when it's being publish in the web server. In this system, the plug-in uses for viewing the 3D terrain was camera view (north, south, west and east - refer Figure 1) , first person view, third person view, walk through, coordinate, and land use map overlaid view.
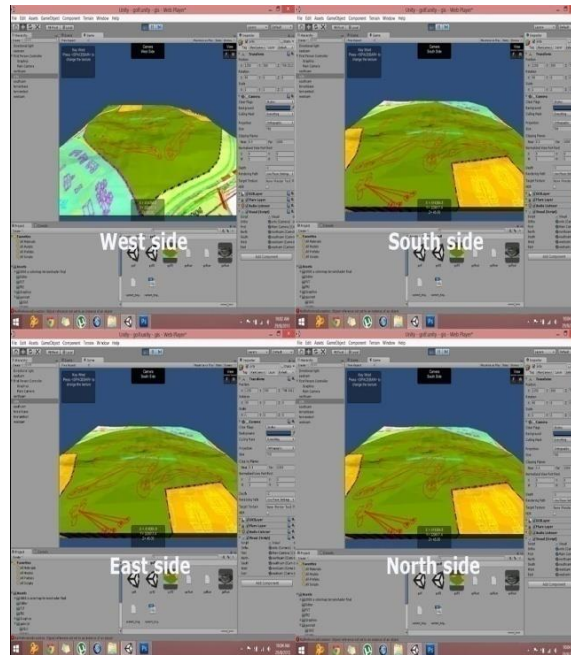
Figure 1. Camera Views of 3D Terrain Viewing From North, South, East and West

Overlaid terrain

After completing the generating of the 3D terrain using unity 3D, the process of overlaying the image data onto the 3D terrain can be started. The unity 3D still being used in this overlaying process. The 3D terrain generated were overlaid with land use map image data. The land use map image were considered as textures and applied using terrain textures that is built-in inside the unity 3D. After the process complete, the 3D terrain overlaid with land use map can be viewed in 3D.

Web based development

After the construction of the terrain have been complete. The web based developments of terrain were started. The Macromedia Dreamveawer was used to develop the complete website for Web based 3D Terrain Visualization. The development process begun by drafting a design for the website based on the developer creativity. Then, the web based format data was arranged according to the design. For the purposed of making it user friendly interface, the website was design based on three frames where it was separated by banner, pull down menu (top), user guide (left) and main frame (display). When the user clicks on the "prototype" pull down menu, the user were given two choice of prototype where the first was "land overlaid" and second was "satellite overlaid". The display of this two link for prototype was in the main frame area. In order to view this prototype, user needs to install the unity 3D viewer. This can be done by clicking on the link "webplayer".

Deployment

Unity 3D as the core development tool which can easily deploy the web based 3D terrain visualization into the web server, in which unity 3D provide options to deploy to multiple platforms such as web based and mobile based. In this system, the deployment is generated into web player format. After that, it's can be deploy to any web server which has capability on viewing the web player format of unity 3D. Unity 3D web player uses its own free viewer of web player plug-in which can be downloaded from the unity 3D website.

RESULTS AND DISCUSSION

When the process of developing the system was complete, the system is then published at web server using ".my" domain. The results of this project can be view at http://www.ruzinoor.my/terraviz3D/. The advantages of this system is that the end user can visualized different types of terrain as long as they have the DEM data and image data of that place. As the results, the terrain can be view in different angle which is from north (refer Figure 2), south (refer Figure 3), west, and east.

Figure 2. The 3D Terrain View From North   **Figure 3. The View From South**

Other than that, the terrain can be visualize in first person view (see Figure 4) and third person view (see Figure 5). In this two types of viewing, the end users can explore the details of the terrain information such as slope area of the terrain. While the avatar moving inside the 3D environments, the coordinates were change based on the avatar location.
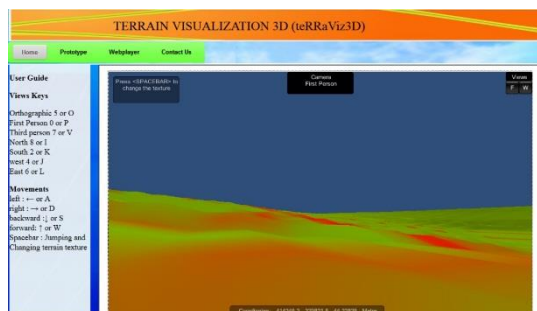
Figure 4. First Person View of 3D Terrain   **Figure 5. Third Person View**

CONCLUSION

Since the terrain have successfully created using unity 3D and deploy on the web server, the size of 3D terrain inside the system was reduce significantly. Some of the issues need to be considered when developing the 3D terrain with GIS data using unity 3D was the coordinate displayed in the system should be exactly similar with the real coordinate on the ground. This coordinate data need to be validated by comparing with the real coordinate data. Besides that, currently the only terrain data (DEM) format that support by the unity 3D was HDR and FLT data which can be generated using ArcGIS software. The user need to be aware that some of the web browser support the webplayer plug-in of unity 3D such as Firefox and Internet Explorer. One of the big advantages developing the 3D terrain with GIS data using unity 3D was its multiplatform engine where from web based platform, it's easily can be convert into mobile platform. The 3D terrain generated using unity 3D also render faster inside

web based environment. It therefore gives benefits to potential visitors, decision makers and planners to explore and gain experience the 3D environment of terrains virtually.

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