

# Using Game Engine for Online 3D Terrain Visualization with Oil Palm Tree Data

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**Abstract**—Nowadays, cartography, otherwise known as mapping, are serving people in multiple aspects of livelihood and administration like planning, rescue, military, and tourism. The information is usually presented in the map by using legends, elevation, and contour. With the passage of time, many new methods of mapping are introduced which are divided into the non-digital and digital version. Another method used is the incorporation of 3D modelling in virtual aspect by simulating real-world data. In the recent years using the game engine is one of the important 3D modelling approaches obtained. The game engine has a lot more capabilities to simulate real-world terrains whereas using database support for terrain visualisation, new functionality can be used. This article discussed how to utilise game engine technology for developing 3D terrain visualisation with oil palm tree data. With the success of the system, it, therefore, gives benefits to potential visitors especially the manager of oil palm plantation, decision makers and planners to explore the online 3D terrain visualisation with oil palm tree data and manage it.

**Index Terms**—MySQL; Oil Palm Tree; Unity 3D; Online.

## I. INTRODUCTION

A database is a digital collection of information that is organised so that it can easily be accessed, managed, and updated. There are different types of databases with various uses, among which relational database is the most common type that uses a table with a key to relate one table to another table. Operational database is the database used by organisations to manage information which is needed by the organisation. Database warehouse is a type of database that collects different information over the years and is used to analyse trends in order to generate reports. Conversely distributed database is another type that uses a single database and has many clients from different locations and places. This type of database can also be referred as an external database. There is another type of database called hypermedia database which is stored as media such as audio, video, animation, text, and graphics so it can be retrieved and used.

Each database possesses a Database Management System (DBMS), that helps the user in managing databases by providing an interface and logic operation for using the databases. Usually, a database contains various information, and each information can be categorised further, for example, a university containing many departments with a lot of students can utilise a database to manage staff and student information efficiently. Utilizing database capability for storing palm oil tree data helps manager of palm oil plantation during decision making. This scenario motivates these studies to utilise game engine as a database tool for data management of palm oil tree. The tool would utilise a game engine named

Unity 3D to create a 3D terrain visualisation that would retrieve database information from the server hosted by MySQL database. The primary aim of this paper is to discuss how game engine technology could be utilised for developing online 3D terrain visualisation with oil palm tree data.

## II. RELATED WORKS

In recent years, a lot of studies on terrain visualisation and oil palm plantation have been conducted. Ruzinoor et al. has conducted an intensive reviewed on terrain visualisation relating to implementation and testing [1], and also regarding the technique and software for visualising terrain [2]. Besides that, Ruzinoor et al. also conducted the study on how effective of terrain visualisation in a different type of GIS software [3] and different type of satellite images [4]. Other than that, Ruzinoor et al. also study and reviewed the potential of the game engine in visualising terrain in a 3D environment. They reviewed the capability of four types of game engines (torque, unreal, CryEngine and Unity 3D) for 3D terrain visualisation and found that Unity 3D is the best. In another study, Ruzinoor and Mohd Hafiz have conducted experiments on the potential of different size contour intervals for 3D terrain visualisation using game engine [5]. Ruzinoor et al. also study the suitability of online 3D visualisation technique for oil palm management using game engine [6].

Shiratuddin & Fletcher [7] developed a 3D environment for Hattiesburg Innovation and Commercialization Park (ICP) for the University of Southern Mississippi using a modified version of torque game engine. In another research by Shiratuddin & Thabet [8], DBMS was utilised as a plugin for torque game engine database that would hold most information as a 3D model to create a design review system.

In a study by Wang et al. [9], they develop an urban virtual reality using Unity 3D game engine which simulates the Campus of Henan Institute of Urban Construction, Pingdingshan location in China.

In another study on terrain visualisation by Shin et al. [10], the author use plugin to support additional feature inside Unity 3D terrain visualisation, the study explain how Unity 3D terrain can be used to simulate seabed environments as well develop a simulation of ship sea route inside Unity3D.

Mateevitsi et al. [11] studied about representing museum artefacts information that also utilises DBMS for torque game engine. In growing palm oil tree, Bah et al. [12] used controlled fertiliser allocation in his studies on palm oil tree cultivation. Palm oil tree requires a flat surface for better irrigation in which the attraction of water into the land is sufficient, and there is no visible water puddle around the

tree; this also allows faster harvesting of palm oil fruit [13]. Diseases also occur on palm oil tree, fungal and root diseases require a careful inspection to determine the infected tree [14]. Asraf et al. [15] studied on identifying palm oil leaves nutrient-disease using computer vision to visualise chemical such as nitrogen.

### III. 3D TERRAIN VISUALIZATION WITH OIL PALM TREE DATA

The development of web-based 3D terrain visualisation using Unity 3D game engine can be divided into several stages which included data preparation, image preparation, construction of 3D terrains, generated terrain using Unity 3D, overlaid terrain, database construction, web-based development, and deployment. All these stages were related to each other where one needs to be completed before proceeding to next stage. Figure 1 shows the construction of steps of development of the tool.

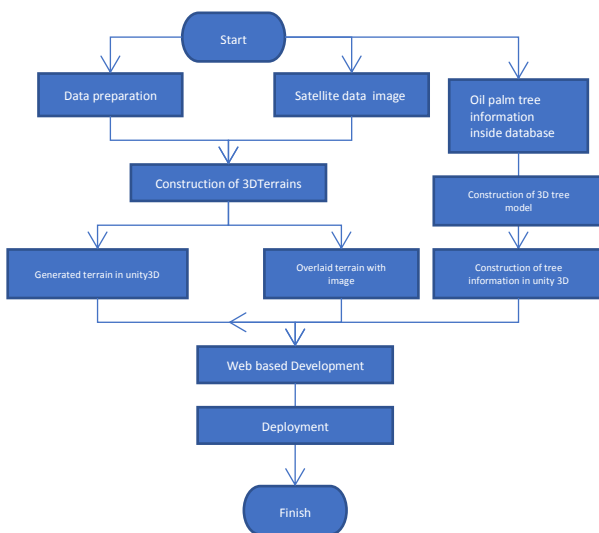


Figure 1: 3D terrain visualisation with oil palm tree data

#### A. Data Preparation

Data preparation for this system development is performed by using the ArcGIS software. The process started by adding the selected terrain data into the project in ArcGIS. Every selected area has a different project file. The data is then converted 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 the game engine was HDR (header) with FLT (float) data format. The projection used for this data was the Rectified Skew Orthomorphic (RSO) Peninsular Malaysia.

#### B. 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 satellite image data were used. The projection used for this data is similar to the terrain data (DEM format) which is in 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. The PCI Geomatica software is used to clip the image data. The four coordinates for clipping the image data is similar to coordinates in terrain data. The process started with opening

all of the image data. Then the process continued with inserting four coordinates to be clipped. Determination of the destination of output files and formatting of files also need to be done. Finally, the data is clipped based on the four coordinates set before and was saved in TIFF format.

#### C. Construction of 3D Terrain

The process of generating the terrains begin with loading the terrain data from a palm oil plantation (which is in DEM format) into a game engine. By using the custom script that was added to the game engine, the scripts then read the float file (FLT) and its header (HDR) to generate a terrain inside the game engine. The terrain generated by this technique would have the information of the terrain data such as location data x, y, and z. The z value represents the height data of the place (measured in meter). This height data is based on the location of the avatar which has to be pointed precisely on the terrain surface. The construction of the terrain inside Unity 3D allows an easier method of construction by applying add-on or plug-in which are available in Unity 3D and Unity 3D assets.

#### D. Generation of Terrain Inside Game Engine

In this stage, the plug-in of the game engine needs to be inserted into the 3D terrain. This plug-in needs to be manipulated and set for the purpose of viewing the 3D terrain. Its implementation was to allow the user to the controls of viewing of the terrain when it is being published on the web server. In this system, the plug-in primarily uses person view for viewing the 3D terrain. Figure 2 shows the raw terrain data generated inside Unity3D.

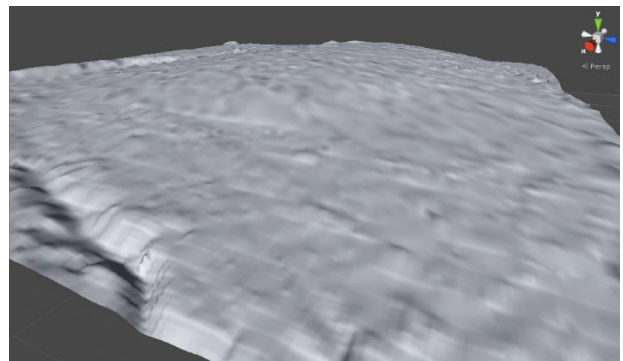


Figure 2: Raw terrain view in Unity 3D

#### E. Overlaid Terrain with Image

After completing the generation of 3D terrain using the game engine, the process of overlaying the image data onto the 3D terrain can be started. The game engine is also being used in this overlaying process. The 3D terrain generated was overlaid with land use map image data. The satellite image was considered as textures and applied using built-in terrain textures inside the Unity 3D. After the process was completed, the 3D terrain overlaid with satellite image can be viewed in 3D.

#### F. Palm Oil Tree Construction

Palm oil tree 3D model is created using 3D modeller software, the tree would imitate real palm oil tree using low polygon 3D model for faster loading when accessing online. The tree was placed based on the original location inside the Unity 3D to simulate actual data coordinate of the oil palm tree location. Figure 3 shows the construction of palm oil tree.



Figure 3: Palm oil tree in 3D modeller software.

### G. Database Construction

The construction of the database can be divided into two parts which are outside Unity 3D and inside Unity 3D (refer Figure 4). The part of outside Unity 3D begins with acquiring the palm oil tree data. The data is then sorted and loaded into the web server that has MySQL database. The PHP and SQL query was used to query the information inside the database. The database contains information such as year of the tree was planted, type of fertiliser, the frequency of fertilising and size.

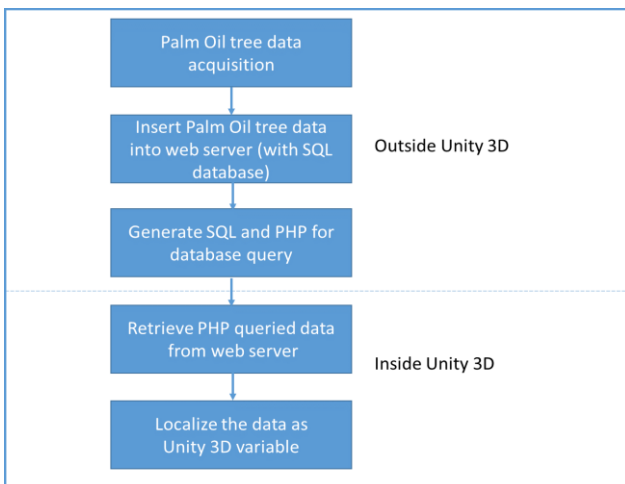


Figure 4: Database construction for palm oil tree

The part of inside Unity 3D, the information created from the PHP file is then used and localised as a part of Unity 3D variable. This would allow the variable to be used inside the Unity 3D object parameter. This variable is set up to allow manipulation of the model of 3D palm oil tree showing the age of the tree. This variable is also used to display information from the database when the users collide with the palm oil tree. Figure 5 shows the database structure in MySQL.

1	IDPokok	int(255)
2	x	varchar(15) latin1_swedish_ci
3	y	varchar(15) latin1_swedish_ci
4	z	varchar(20) latin1_swedish_ci
5	Color_Disease	char(255) latin1_swedish_ci
6	Radius	char(255) latin1_swedish_ci
7	Height	char(255) latin1_swedish_ci
8	Size_of_Tree	char(255) latin1_swedish_ci
9	Year_of_Planted	char(255) latin1_swedish_ci
10	Fertilizer_Quantity	char(255) latin1_swedish_ci
11	Nutrition_of_Tree	char(255) latin1_swedish_ci
12	Soil_Status	char(255) latin1_swedish_ci
13	scalex	float
14	scaley	float
15	scalez	float

Figure 5: Database structure in MySQL

### H. Web-based Development

After the construction of the terrain was completed, the web-based development of terrain was started. The Macromedia Dreamweaver was used to develop the complete website for online 3D Terrain Visualization with oil palm tree data using game engine. The development process began by drafting a design for the website based on the developer creativity. Then web-based format data was arranged according to the design. The display of this two link for the prototype was in the mainframe area. To view this prototype, the user would need to install the Unity 3D viewer. This can be done by downloading it from the Unity 3D website.

### I. Deployment

Unity 3D is the core development tool which can quickly deploy the web-based 3D terrain visualisation into the web server. It provides options to deploy multiple platforms such as web-based and mobile-based platforms. In this system, the deployment is generated into web player format. After that, it can be deployed to any web server which has the capability of 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.

## IV. RESULT AND DISCUSSION

After completion of the process of developing the system, the system was then published at web server using “.net” domain. The results of this project can be viewed at <http://hafsaruz.net/prototype/prototype6/prototype6.html>. The advantages of this system are that the manager of oil palm plantation can explore their plantation in an online 3D environment. They can view their plantation in different angles of view such as from north (refer Figure 6), south (refer Figure 7), west (refer Figure 8) and east (refer Figure 9). With the terrain information in 3D view, the manager can decide on the runoff water in each of the oil palm trees. Other than that, they also can plan on the route of the vehicle inside their plantation.



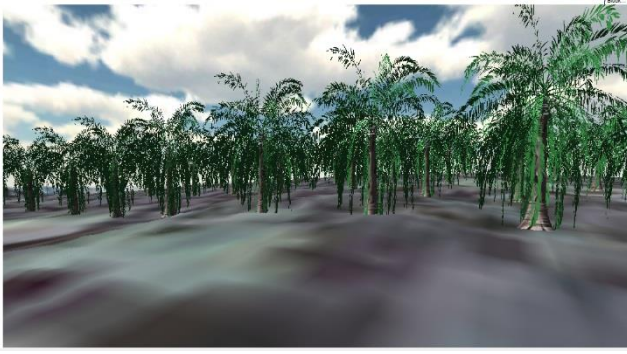


Figure 6: View from North

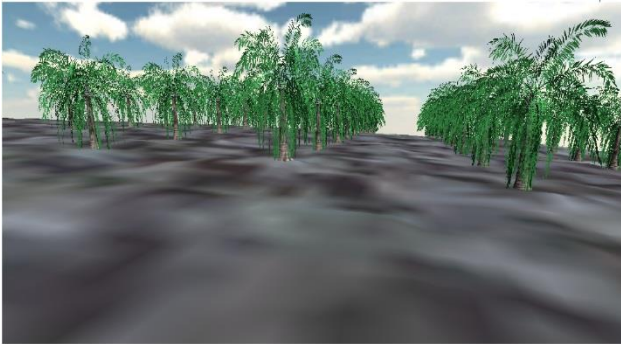


Figure 7: View from South

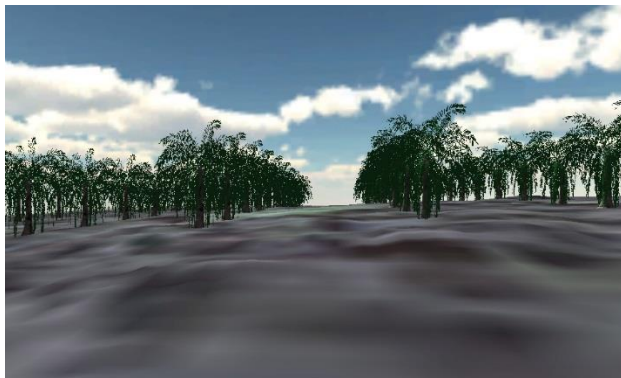


Figure 8: View from West

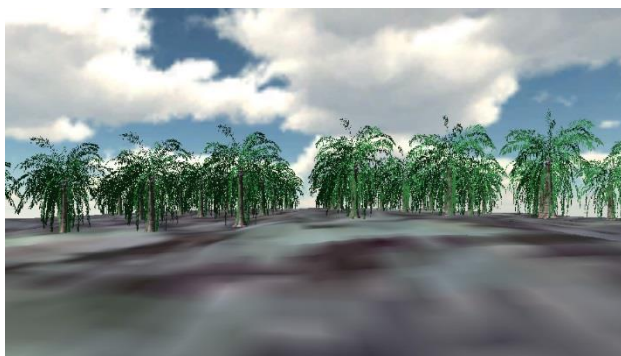


Figure 9: View from East

The most important contribution of this project is that the manager of oil palm plantation can know the status of each of the tree. The information is available for each tree such as the ID, location, radius, height, and fertiliser. This information can be viewed by the manager when the avatar collides with each of the three inside the environment (refer Figure 10). This could be done by using the DBMS which is set up in this project.



Figure 10: Collision with a tree will show information on each tree.

## V. CONCLUSION

The development of online 3D terrain visualisation with palm oil tree data using game engine technology (Unity 3D) achieved success. It proved that game engine technology could be integrated with the DBMS in order to develop an application for managing oil palm plantation. The tool would benefit palm oil owner and manager as they can view palm oil tree information through online. Necessary tree data such as frequency of fertilising and information about the health of the tree can be viewed. These would facilitate the owner and manager to make a decision on the palm oil plantation. The online availability of the tool helps the owner and manager to view information of the tree from any place provided with internet facilities. This tool can also aid in educating the public, as they can utilise the tool to understand about palm oil tree and help the public to understand the current scenario of planting palm oil tree. It, therefore, gives benefits to potential visitors especially the manager of oil palm plantation, decision makers and planners to explore the online 3D terrain visualisation with oil palm tree data and manage it properly.

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