Constructing Virtual Urban Environment Using Game Technology

A Case Study of Tokyo Yaesu Downtown Development Plan

Aswin Indraprastha [1], Michihiko Shinozaki [2]
[1,2] Shibaura Institute of Technology, Japan
[1] m507421@sic.shibaura-it.ac.jp, [2] sinozaki@shibaura-it.ac.jp

Abstract. *Recent game technology ascends development of low-cost virtual environment to the next level in two domains : reality representation and user interaction or engagement. In architecture and urban design realm, realistic 3D representation become more important in such way of conceptualizing ideas and analyzing the context of design problem. This research will present development of virtual urban environment using game engine technology. Aim of this research is to promote game engine as a tool for visual representation, visual analysis and further basic tool for urban design study. At the end, we point out potentials as well as constraints both in technical and design method issues in game technology based on the research findings.*
Keywords: *Game engine: virtual urban environment; design study; visual representation; visual analysis.*

Introduction

Today video games are among few technology which shape our post modern culture. In US almost 75% of heads of households play computer or video games (Entertainment Software Association, 2005) and game habit can be found everywhere from working desktop to wireless palm-held device with or without network connection. Video games in which encompasses virtual world played and visited by millions people everyday (Bartle, 2003). Despite of its leading technology in graphic, interface and multimedia, video game allow learners to (Kurt, 2006):

- visualize system in three dimension
- compare simulation with their understanding of a system
- manipulate variables

This paper intend to present research on the feasibility of game technology to create interactive 3D environment that leverage photorealistic graphic and immersive navigation as a tool for urban analysis and visualization.

3D Urban visualization now plays important role in policy making. The virtual 3D environment on particular urban area could help for better holistic understanding for policy maker and every stakeholder (Hunt and Waller, 1996; Schnabel, 2004). However, most CAD and GIS application are not equipped with such 3D view with navigation intended to the user. In particular, 3D game engine provide first person view

as well as any programmable view to create engaging navigation thorough virtual environment. By using such game engine, it is possible to create engaging interaction such as data bounding on particular object (Andreoli, et.al, 2005), Artificial Intelligence on Non Playing Character (NPC) to interact with player and/or environment. Among additional features that makes video game engines attractive is capability of obtaining scalable environments that can enrich the quality of experience in virtual world (Fairuz, 2003).

Methodology

This research begins in investigating the potential ability of Unity3D game engine to create a virtual environment application that not only as a medium for visual representation but also as medium for performing visual-based analysis in the early stage of design process. As visual representation game engine based application allows user to interact in way of exploration by using various types of navigation techniques. Other type of interaction is way of explanation by using various type of user interface and media embedded techniques (Indraprastha, 2008).
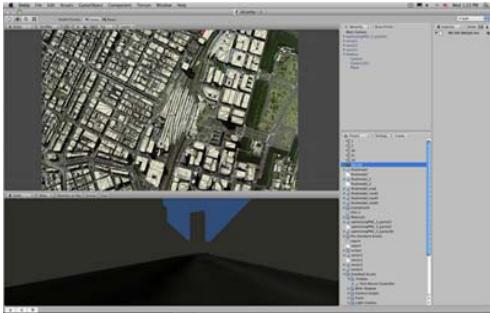
The game engine that is chosen for this research is Unity3D (www.unity3d.com) by several reasons. First, it encompasses rich built-in features from 3D creator and editor, real-time light and shadow as well as shaders to increase quality of graphic representation, terrains and physic engine and user interaction

tools. Second, it has ability to read native file format from various 3D application software. Once 3D data imported in Unity3D, it will automatically synchronous with its counterpart in other applications. Other reason is it supports various types of scripting languages namely JavaScript, C# and a dialect of Python called Boo. This scripts can be used for various purposes on game scenario and user interaction. This game engine application is used on a Apple Macintosh Macpro Dual Core Intel Xeon with OSX 10.5 installed.

Constructing Virtual Urban Environment

Case study is an urban developed area at central district of Tokyo, Yaesu district. This area is about 220 000 square meters and planned to become new development area. Yaesu area is consist of mostly office and commercial middle rise buildings and many of them are registered as old buildings.

The development process of the virtual urban environment follows the sequence shown in figure 2. The 3D geometry data obtained from GIS application (ArcGIS) prepared by private company (Tokyo Digital Map Corporation, 2007) in the *.obj format to be interpreted in Blender application.

At the scale of urban, the complexity of polygon and texture mapping system become main consideration. GIS application provide 3D polygon exporter but not including any texture mapping system. In case study, only building has its 3D geometry data in ArcGIS. The orthographic photograph of each building facade is obtained from mapping service company. This research use poly reduction technique and using smart unwrap technique for texture mapping in Blender to address the polygon complexity and mapping system issues. Furthermore, building's data attribute from ArcGIS is also obtained in text-based file format (*.csv). Figure 3 shows detailed process of overall 3D construction.

Figure 1
Unity3D 2.0 user interface showing urban environment under development

Figure 2
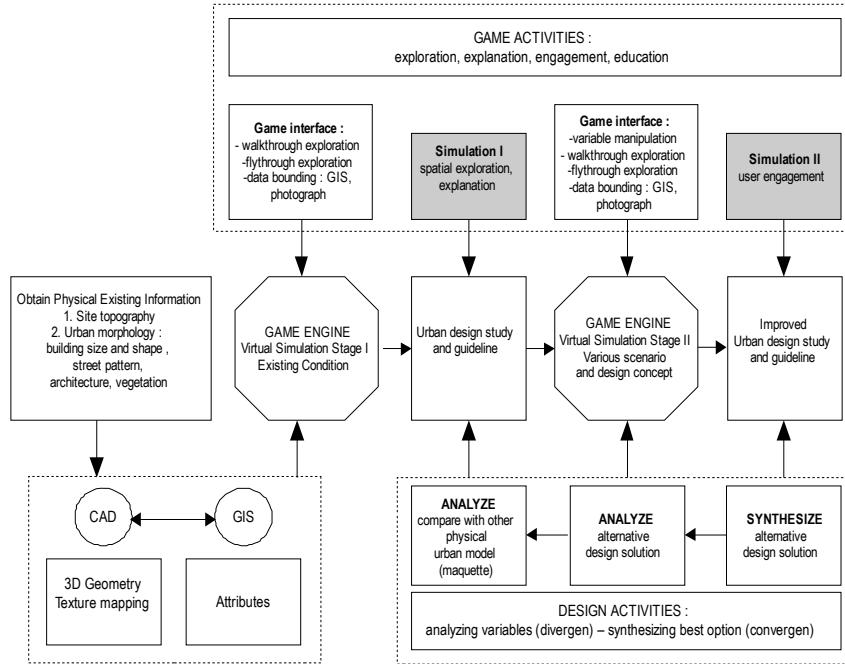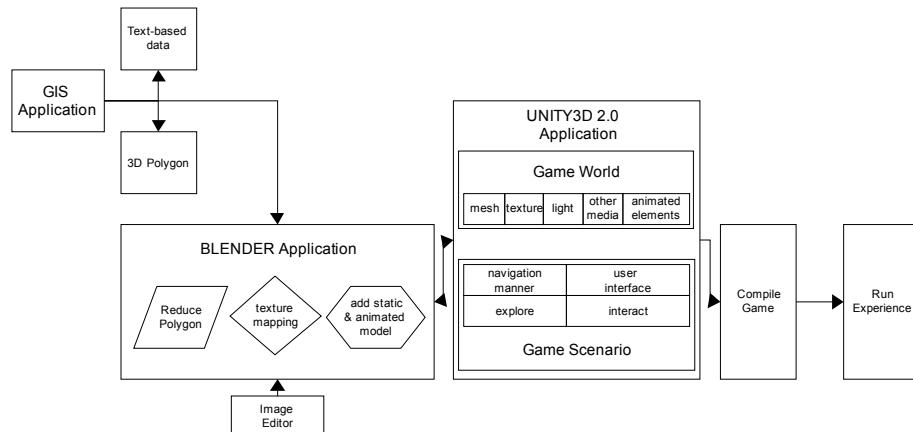*Research stage showing the development in constructing virtual environment*

Figure 3
Overall process to constructing virtual urban environment from GIS application and 3D application

Static Features in Game Engine

Once 3D models which already packed with mapping system saved and opened in Unity3D, next step is to match each of mesh with its image texture. The static features in this virtual environment are including urban elements namely : buildings, parcels, road, street vegetation and street furniture. Due to large amount of polygons, the complexity of each 3D model has been compromised. The real cost in designing virtual

www.mocapdata.com to be embedded with human model in Blender. Animated vehicles entirely done in Blender. Figure 5 shows snapshot of animated features in Unity3D.

Game Scenario and User Engagement

As suggested in research approach, construction of virtual urban environment using game engine
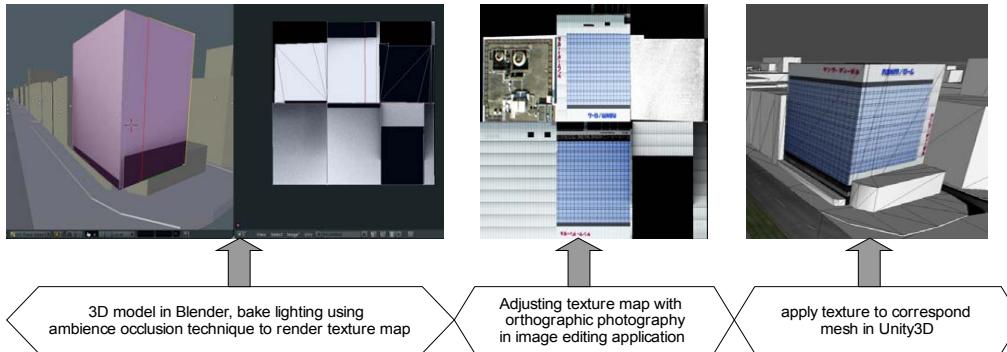

Figure 4
Procedure of texture mapping including using bake lighting technique

environment is the size of objects in memory (Maher, 2000). Instead of using detailed model, we use image mapping on a simplest 3D mesh. The billboarding technique also applied to render vegetation. As for real-world effect such as sky, fog, cloud, Unity3D provide such built-in element. Figure 4 shows procedure of texture mapping which involves Blender, image editing application such as Adobe Photoshop and Unity3D.

Animated Features in Game Engine

To give a virtual environment sense of movement other than the player itself, we applied several animated avatars (people) and vehicles. Human figure can be modeled in Blender and for its movement there are types of techniques : using manual keyframe animation and using pre-animated motion capture data. This research is using free motion capture data from

intend to promote further usage of game engine capability. In urban design process, this application will plays role as tool for conducting visual-based analysis (Meeda, 2006) : figure-ground, diagrammatic relationship, block and boundary, and serial vision. Our hypothesis is game technology, in this case Unity3D, has advantage to role as design tool and thus perform some spatial analysis. One advantage is its flexibility in a way of automatic synchronization to 3D application. This synchronization makes short time of geometry deployment and shortener overall virtual construction process. Other advantage in using game engine is its flexibility to create navigation mechanism within virtual environment as well as any programmable user interface.
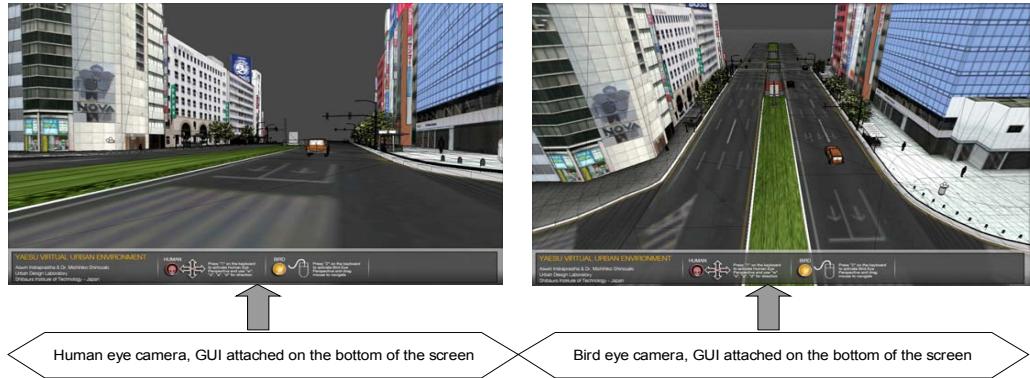
In a game scenario that we developed, we provide mechanism of two kind of user engagements :
1. exploration mechanism using camera-based

For further interaction which involves not only way of exploration but way game engine could be a tool for visual based analysis, we present three basic urban analysis which are : figure ground, section analysis, and swap mass. For this purposes we use interactive mechanism based on click-drag-movement of the mouse relied heavily on the Javascript programming.

navigation : first person perspective, bird eye perspective and using point-click navigation. This exploration mechanism use combination of keyboard and mouse movement as main input.

Findings and Discussion

Undoubtedly, Unity3D game engine has capability for creating such interactive virtual environment with object-oriented programming and further, open possibility to become tool for such media that bridging between 3D application and realtime realistic simulation.

Human eye camera, GUI attached on the bottom of the screen

Bird eye camera, GUI attached on the bottom of the screen

2. interactive mechanism using point-click-<event>. This interactive mechanism is based on the scenario in which such visual-based analysis is take an action.

In human eye exploration we use first person perspective with standard degree of freedom : move and slide using keyboard key (w,a,s,d), turn and look using mouse movement. In bird eye exploration we use mouse to perform orbital movement around object.

In summary, the case study presented in this paper is an initial project that attempt to develop urban scale virtual environment with these following enhancements :

1. view point variation on how user do the exploration within virtual environment by using different camera

2. rich information retrieval by applying behavioral programming on particular object

3. some basic visual-based spatial analysis to lever-

Figure 7
Snapshot on interactive
mechanism

	Spatial analysis : Figure - Ground *What it shows* : relief map of figure (building) and ground (road,space) *Why it is important* : to show urban pattern, road structure, building arrangement and pattern *What is the advantage using game engine* : dynamic inset camera could depict real-time 3D situation on particular location.
	Spatial analysis : Cross Section *What it shows* : orthographic view of street side *Why it is important* : to show urban typology *What is the advantage using game engine* : dynamic inset camera could depict real-time 2D of contextual environment
	Spatial analysis : Swap Mass *What it shows* : spatial perception on 3 dimensional building mass *Why it is important* : to analyse how building shape would have effect on its context *What is the advantage using game engine* : flexibility to import 3D mesh and put on the chosen location.

age higher spatial comprehension of traditional method

As a media for reconstruct actual and physical setting which involves consideration on graphics appearance, virtual environment in Unity3D game engine nearly reach same level as those by using high level graphic system. However, on this research in particular, we attempt to use real world effect such as dynamic shadow and lighting, three dimensional vegetation, and fog as built-in game environment in Unity3D. On the urban scale these features result on the slow performance in execution. Regarding on the scale of the virtual world, Unity3D works best on the architectural scale with full feature effects .

Other research findings on constructing virtual urban environment using Unity3D game engine

On Constructing Virtual Environment both static and dynamic game component	On Constructing Game Scenario and User Engagement Mechanism
flexibility on constructing 3D geometry in a way of real time synchronisation from external tools such as 3D application	develop means of exploration using camera-based navigation
ability to read native mapping co-ordinate system (i.e Blender)	develop multimedia information retrieval based on object behaviour
ability to read pre-animated polygons (.blend, .fbx)	develop three basic user interaction for visual-based spatial analysis
although ambience occlusion is not possible, this effect can be obtained by using bake lighting in Blender	all game scenario and user interaction relied heavily on the comprehension of Javascript language. There is no tutorial or how to for non-programmer user to create such interaction mechanism
alpha rendering for billboarding technique	
	depend on the particular purpose, any text-based file can be read and the retrieve on any programmable user interaction

described on following table :

Aside from its flexibility to connect with external sources, game engine based virtual environment using Unity3D can be deployed on multi platform computer as standalone application as well as web based application. In the web-based environment, this application can be alternative solution among other technology such as VRML (Virtual Reality Modeling Language) with its advantage in object oriented programming.

However, it is interesting to look at other urban scale visualization application such as Google Map with it's Street View navigation. On such application, user can explore the map and information visualized in 2D and 3D (using serials of panoramic photos).

There are some challenges in the context to extent the potential advantage using Unity3D for constructing virtual environment from architectural perspective :

- Multiuser interface for creating virtual architecture with collaboration
- Virtual representation for architectural heritage with advancement in using web 2.0 technology.
- Application for architectural or urban analysis in conjunction with agent-based simulation

Acknowledgements

References

Andreoli, R., et.al.: 2005, Interactive 3D Environments by Using Video Games Engines, Proceedings of the 9th International Conference in Information Visualization, IEEE.

Bartle, R.: 2003, Designing Virtual Worlds, New Riders Games, Indiana.

Fairuz, S and Walid T.: 2002, Virtual Office Walkthrough Using a 3D Game Engine, Journal of Design Computing, 1V(2002).

Hunt, E. and Waller, D.: 1999, Orientation and Wayfinding: A Review, in ONR Technical Report N00014-96-0380, Office of Naval Research, Arlington , VA, USA.

Indraprastha, A.: 2008, Integrating CAD and GIS for Visual Simulation on Urban Design Study by Using Game Engine, Proceeding of the World Conference on Educational Multimedia, Hypermedia and Telecommunications.

Maher, M. L., et.al.: 2000, Designing Virtual Architecture, Proceedings of CAADRIA 2000.

Meeda, B., et.al.: 2006, Graphics For Urban Design, Thomas Telford Publishing, London.

Schnabel, M. A.: 2004, Architectural Design in Virtual Environment, Published PhD Dissertation, University of Hongkong.

Squire, K.: 2006, Video Games in Education, Comparative Media Studies Department, Massachusetts Institute of Technology, Cambridge.

Apparatus

Adobe Photoshop, Adobe System Incorporated, San Jose, California, USA, www.adobe.com.

ArcGIS, GIS application, ESRI Corporation, New York, USA, www.asri.com.

Blender, Open-source 3D application software, Blender Foundation, Amsterdam, The Netherlands, www.blender.org.

Unity3D, Game engine application ,Unity Technology ApS, Copenhagen, Denmark, www.unity3d.com.