INTERACTIVE 3D SIMULATION SYSTEM IN GAME ENGINE BASED COLLABORATIVE VIRTUAL ENVIRONMENT FOR ARCHITECTURAL DESIGN COMMUNICATION

PRITTIPORN LOPKERD, PINTO JINUNTUYA
Faculty of Architecture and Planning, Thammasat University
lpritti@gmail.com, pinyoji@gmail.com

Abstract. This paper will present an innovative prototype for architectural design based on the Cryengine2 technology, which can generate virtual environments. The objective is for exploratory study and analysis method of using computer game engine that have several features for architecture design process, relate to real-time collaborative virtual environment could derive from multi-player aspects for designer team, and easily level of representation and basis for perception of owner or general user. In addition, the Cryengine2 have easily using and development for designer who is non programmer, and present realistic virtual worlds featuring user friendly interaction. Finally, this paper attempts to explore and suggests novel tools developed within to implement architectural design communication.

Keywords. Interactive Communication, Game Engine, CryENGINE, Visualization, Collaborative Virtual Environment.

1. Introduction

Architectural design communication depends on such models. Architectural product is based on design model created in the designer’s mind. When designers create, they make up mental models loaded with various kinds of information (form, dimensions, relations, materials, colours, structure, etc. of spaces) about the design (Synyapili, 1997). Real architectural product lives in four dimensions.

Nowadays, computer can play an important role in the architectural industry especially generating 3D virtual environment (VE) which is an important tool for architecture design as media in communicating the relationship of physical elements. Its considered as an important media in representing the architecture
design which enhance learning and perception of related people to make decision before actual building. The main part of virtual environment is inclusion of 3D model and context which could help to enhance the perception as realistic according to the real environment. It could help to study & analyze the design guideline for visualization and could support visualizing and understanding the architecture design before construction. Therefore the tools, that are able to generate the VE as real and able to create physical elements as real, are truly important to enhance understanding and allowing public participation in architectural design decision-making.

2. Background

The process in generating VE is quite complex and consumes time and technology resources so a tool for improving VE is very important. At present, computer game technology is another interesting option to consider as an architectural tool because the unique feature technology in duplicating VE and able to give shade and shadow efficiently in real-time. This unique is an outstanding feature, efficiently displays the result and manages hardware resources appropriately.

A group of developers are likely to share their experience and knowledge to general users or designers, who are not programmers, to study and able to create their own architectural work through online-communication. In addition, the 3D environment in computer game can support and enhance the perception of designer process in term of real-time interaction and perception (More, 2007), especially first person shooting (FPS), which is able to present 3D view to have the same view as player view. This function is the same as generating 3D architecture which is able to give walkthrough view and control movement.

Architectural applications have also been around for many years, finding in game editing a way to quickly visualise buildings and prospective constructions with a low cost approach (Sifniotis, 2008). Considering all computer technology tools, we see that the computer game technology is the most efficient software in generating 3D environments and VE that are able to interact with users easily and fast. Multiplayer is the other application that reserves for collaborative environment and able to give a chance to software developer to participate in development. End-users are also able to learn, create the context and generate the new environments by themselves through this software system. Computer technology is an important tool in 3D media which is able to apply the advantages of computer games to many education areas. In other areas, this technology system is used to improve presentations as well provide entertainment.
The main concept in generating 3D design model and simulated VE and creating the context is to enhance the participation of real-time collaborative VE. In addition, this study is conducted to be a guideline for the user interface between user and interactive VE to reserve the participation of people who are involved in architectural design process and the context. It also could be used as a media for architectural representation which is easy for perceiving and understanding by general users (included developer and owner) and as a guideline in applying architectural practice and architectural education (Sifniotis, 2008).

2.1 COMMUNICATION IN COLLABORATIVE VIRTUAL ENVIRONMENT

The process of architecture design needs to have the cooperation between the architect, team work and developer or project owner (Jung, 2000). Internet technology could support or enhance the collaborative communication by many programs such email, instant message or even presenting the report through web blog. Collaborative design could be synchronous and asynchronous at the same time or with different timing (Brinck, 1998). In both cases, it would be useful for related people and users who are in the same place or different places by using email or sharing files at different timing during chatting, using MSN, online multiplayer at same time.

Collaborative virtual environment (CVE) is the way to correspond in the same environment (Kerr, 2002) as a virtual place for meeting, communicating with others or representation or avatar or virtual objects (Churchill, 2001). In technical aspect, online communication between client and server, environment information would be considered as a part of server while users or client who are in different places would be able to connect through the server under same VE to exchange the information or to do something together.

2.2 COMPUTER GAME TECHNOLOGY IN ARCHITECTURAL DESIGN

The game engine is the main part needed to generate and develop games or application software which needs immediately correspondence. Mostly developer game companies create engine game, through middleware or software for developing game by gathering many components for developers such as graphics, sound, physics system, or AI function. For the end-user who is a non programmer wishing to create a game level, this tool is called MOD or Modification (Guilfoyle, 2007). Between 1996-1999 (Sifniotis, 2008), game engines have been developed for projects or research in architectural study, research, and vocation such as Unreal engine, Half life engine, Quake engine, etc. For CryEngine, Marc Herrlich (2007) created a prototype interactive landscape architecture tool based on the game Farcry.
3. CryEngine2 Technology

The CryEngine2 is a new next-generation engine created by software developers Crytek GmbH team studios in Germany and used in the game Crysis in 2007 (Mittring, 2007). The engine itself is accompanied by an interactive editor tool called CryEngine Sandbox2 Editor, which is installed together with Crysis game and is free for non-commercial uses (www.cryengine2.com: May 2008), the source code to the engine is not opensource. However, it allows designers to create and modify events, triggers, other game logic and high-level functions, to use the Sandbox2 Editor in game Crysis with the MOD-SDK become available after game Crysis has released (www.crymod.com: June 2008). The run time engine is fully integrated into the CryEngine Sandbox2 Editor to give designers “What you see is what you play” functionality. Also, it is a very intuitive tool as it edits levels in real-time.

![Figure 1. CryEngine Sandbox2 Editor](image)

The decision to use CryEngine2 was made mainly because it supports the visualization relationship between environment and architecture. In addition, the engine produces very high quality graphics and visuals (Trenholme, 2008). The high resolution real-time interactive editing and modification, includes features that are related to architectural design process such generating terrain map, dynamic time of day, dynamic world sounds, environment audio, real-time lighting with dynamic shade & shadow, network client and server system which support multiplayer, etc. Figure 1 shows a screenshot of CryEngine Sandbox2 Editor with 3D model for material editing. In this research, the hardware was a PC (Pentium4 3 GHz, Ram 2 Gb, GeForce 8800 512 Mb).
4. Developing 3D Simulation System

The development process of the 3D simulation system for architectural design communication follows the overall workflow and sequence shown in Figure 2. The process is, creating 3D model and material; generating level and adding features to environment; importing and adding features to 3D model; and connecting interaction and behavior.

It begins with a 2D drawing or 3D model from 3DS MAX, MAYA or CAD Software (AutoCad, Rhino, SketchUp etc.) which was then transformed into 3D model using 3DS MAX. To import 3D model into 3DS MAX, the next step is to convert to poly or mesh and create material by Crytek Shader (Plug-in for 3DS Max). For materials, we create a material in MAX and transfer that information into .MTL file, where it can be edited with the Sandbox2 Editor. Once 3D modeling is completed the model is then exported to the *.CGF file format by export dialog (3DS Max Exporter Plug-in). We import an entire 3D model with a low number of polygons into the game engine’s environment (Sandbox2 Editor). A technique to overcome this limitation is to break down the model into smaller components.

Secondly, CryEngine Sandbox2 Editor is used to generate level and add features to environment, i.e. terrain, texture, vegetation, lighting and time of day, sound/audio, entity (road, river, vehicle etc.), can be made using the standard Sandbox2 Editor tools. One is able to create a realistic ground texture in Sandbox2 Editor from GIS data (Herrlich, 2007).

Thirdly, once the environment is completed, we import 3D model into the CryEngine2, the Sandbox2 Editor is used to add features. The Crytek game engine supports several features to enhance interaction 3D simulation, i.e. real-time lighting, texture mapping, audio effects, and interaction.
The last step is to connect interaction and behavior between users, virtual environment and 3D model, through changes of viewed locations, typed commands, mouse clicks, keyboard presses, or other means of interfacing. Interaction features are important for users of a virtual environment, as it will relate what they are seeing in the virtual environment to the real world. This feeling of realism is important to convince users that the environment is realistic and represents the real world (Mays, 1998 and Miliano, 1999).

Figure 3. Flow graph with to change the surface material of model

Figure 3 shows flow graph is used to change the surface material of model when user walkthrough and press key to interact with the 3d model. Figure 4 presents switching flow graph to control interior lighting. CryEngine2 accepts and responds to user activity in real-time. This feature is incorporated and can be visualized and experienced in the virtual environment of the interactive 3D simulation.

Figure 4. Flow graph to control lighting on real time
5. Comparison and Evaluation

For teaching computer-aided design studio, we utilised CryEngine2 as the design media and this is an advantage in a short three weeks undergraduate studio context for study and development project of learner (see Figure 5).

CryEngine2 can reduce the learning curve by providing a set of features and asset management tool which immediately editing and development with working environment while understanding of learners could be enhanced. Differences between existing systems based on animation/motion software and CryEngine2 as shown in Table 1. This working procedure is taught to a class of undergraduate students.

Tooling comparison for architectural design process is considered about perception and interaction degree by ranking visualization architectural design and communication design. Communication degree could be categorized into three scales to define the degree of information processing and visualization in architecture (Senyapili, 1997) which consist of, interactivity scale, time scale and rendering scale. The relation of three scales could define 3D coordinate system which intercept point of all three scales is originate point of traditional
drawing which is called paper-bases media. The values of all scale of axis which are moving from intercept point to close the reality. It could present the efficiency of technology which could support architectural design process. Figure 6 shows diagram to calibrate game engine and other 3d simulating application for architectural communication.

![Interaction Diagram](image-url)

_Figure 6. Tooling comparison diagram for architectural communication_

The analysis of architecture and design is related to building, people (user, architect, designer), and environments (natural and human-created environments). All the three groups are related and impact each other. Figure 7 shows the relationship between CryEngine2 and the 3D design process.

<table>
<thead>
<tr>
<th>Schedule</th>
<th>3D with Mixing Motion</th>
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<tr>
<td>Week (one time a week)</td>
<td>AutoCAD</td>
<td>3DS MAX &amp; CryEngine2</td>
<td>3DS MAX</td>
<td>After Effect</td>
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TABLE 1. Working procedure of 3D simulation system.

<table>
<thead>
<tr>
<th>Workflow in 3D visualizing</th>
<th>Drawing 2D</th>
<th>3D Modeling</th>
<th>Texture/ Lighting</th>
<th>Animation</th>
<th>Render</th>
<th>Compositing</th>
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<tr>
<td>3D with Mixing Motion</td>
<td>AutoCAD</td>
<td>High-Polygon</td>
<td>3DS MAX</td>
<td>High-resolution texture</td>
<td>After Effect</td>
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<tr>
<td>Game Engine</td>
<td>AutoCAD</td>
<td>3DS MAX</td>
<td>3DS MAX &amp; CryEngine2</td>
<td>Cry-Engine2</td>
<td>Level Design</td>
<td></td>
</tr>
<tr>
<td>Week (one time a week)</td>
<td>Low-Polygon</td>
<td>Low-resolution texture real-time lighting</td>
<td>Flow Graph</td>
<td>(real-time)</td>
<td>Level Design</td>
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6. Conclusion and Future Works

This paper presents existing computer game technology such CryEngine2 (with Sandbox2 Editor), to build and support system for architectural design communication. So far, we developed CryEngine2 integrated with learning curve in architectural design studios. Interactive 3D simulation based on a game engine, may encourage new understanding of design process and space perception for first year architectural students. It could also encourage participation in the 3D environment learning process to enhance the ability of perception and understanding space in architecture along with shade and shadow. This tool could improve communication and enhance collaboration and decision-making. Online features could improve the connection of online database of material to communicate with supplier or dealer.

So game technology won’t replace CAAD software but it can help with real-time 3D visualization. However, this paper is primary a guide for interested people to see how computer game technology can be applied to the architectural design process. In future work it will be necessary to develop and apply this technology to actual environment design projects.

References

IEEE, Esbjerg, Jylland, pp. 264-268.


