To Proceed Analysis of Dynamic Virtual Environment by Using Physical Model as a Protagonist

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Abstract
This paper intends to combine architecture with state-of-the-art software technologies and operational methods of other domains to free architectural rendering from the restrictions of cold, still graphics or unrealistic computer pictures. The author transforms physical models into digital models through industrial design software, and synthesizes these digital models into motion pictures of the environment via film production software. This way, a designer can effectively turn the ideas of his mind into rough handmade models, instead of spending enormous amounts of time building computer models, and viewers will be able to quickly grasp the conditions of the site through the motion pictures.
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1 Introduction
Vision simulation always possesses a dominant influence on the development of environment analysis and the design process (Fukuda 2002). As a result, before construction designers are used to synthesize their design works with the environment photos in order to provide samples of future images (Liu 2001). In the domain of industrial design, using techniques in reverse engineering to transfer hand-made physical models automatically to digital models helps avoid obstacle and practice in the software. On the other hand, in the domain of popular art, designers in the movie industry use dynamic Camera-matching techniques originating from 20 years ago to gather information from other realms and keep on updating new devices combined by hardware and software. Nowadays with the devices and more powerful digital tools, we could build a virtual space in which an audience cannot distinguish reality from modeling (CG 2001).

With progress in software technology and hardware computation performance, the industrial design sector and filmmaking industry have begun to utilize automatic high-speed tools to enhance efficiency (Paul 1996). In the area of architectural and environmental design, however, designers are still relying on the still photomontage technique of the over ten year old programs such as Photoshop. So the ambition of this paper is to shorten the distance between designers and digital development: to utilize the advantages from the movie industry, including digital techniques, precision, velocity, and low-price in order to efficiently observe the physical model on the real site and present a more high quality, dynamically synthesized film.

2 Camera-Tracking Software
In 1975, George Lucas formed ILM (Industry Light Magic) Studio for his movie, Star Wars, where he tried to repeat the camera path for composition of flying scene of spaceships mechanically. These scenes have shaped the camera-matching technology, and the digitally controlled camera path has become the mainstream of the filming industry for the past 20 years, along with advancement in software and hardware technology.

With the renewal of computation methods and program language, it has become a trend to use camera-tracking software and automatic computation cameras to replace huge mechanical devices. The change results in significant cost savings and a wider application of camera-matching techniques due to a lowered threshold (Figure 1). Using the dynamic synthesizing software 2d3 Boujou—which was awarded in Ammy Engineering Technology Award 2002 for example (Boujou 2001)—designers now only have to input the film into the software and Boujou will automatically grab trackers such as the specific positions of the signboard and cornice. Through sequence frames computation, Boujou will automatically produce information concerning the movement and rotation of the camera during the filming and allow designers to freely apply the data. For a film of 10 seconds, the automatic computation only takes 30 minutes.

Figure 1. Camera-tracking software
3 Silhouette Modeling

In the field of industrial design, due to the limit of 3-D modeling it is very difficult for designers to turn the design in their minds into digital models if they have not been through long-term training. As a result, reverse engineers utilize contact, photoelectric or photographic 3-D scanning techniques to save time and to automatically and accurately transform design concepts into computer model through manual production of simple models (Edward 2001).

Silhouette modeling is a new approach that employs reverse engineering. The only device it requires is a rotating plate at the numbered point. Quality models can be quickly and efficiently produced this way, and there will be no ill combination between polygons breach of the model. Silhouette Modeling takes a 3-D cylinder or cube, and according to the 16 Silhouette Lines of the object, it conducts 16 times of subtractions in Boolean to obtain a digital model that simulates the physical model (Figure 2). After the pictures taken from various angles are merged into a UV picture, we can produce a textured model that contains up to 10,000 faces.

Figure 2. Silhouette modeling

4 Exploration

After reviewing the newest development of other domains, if the presentation of architecture designers is to reach the quality of dynamic environment animation technique with the same quality as a movie, then the huge size of the camera-matching tool, the expensive budget, and the limitation of the software remain unsolved questions. Applying these to the architecture domain is not economical at all. Therefore in the domain of environment and architecture design, we still use static photomontage software such as Adobe Photoshop to simulate reality. However, the effects and sensation of still images are much inferior to dynamic camera-matching motion picture. It naturally becomes a goal for the environmental engineer to pursue how to insert accurately a hand-made model for effective study in the dynamic virtual environment. Hence, the objective of this research is a study of how to apply cutting-edge software and techniques of industrial design and the movie industry to the environmental analysis in order to reach a high level of dynamic motion simulation. The hope is to enable designers using simple workflow to observe the relations between their design works and the whole environment on the concept of animate timeline, and at the end, to present the synthesis film with movie quality.

5 Media Steps

This research is focused on applied media. The hardware used is only a specific rotating plate that is marked with numbers for D-sculptor (D-sculptor 2002). The software used is 2d3 Boujou and d-vw D-sculptor which comes from other professional domains. The 3D Studio Max is utilized as post-production software to render synthesized film.

5.1 Automatic Generation of Digital Model

Place the manually made physical model on the rotating plate that is marked with numbers and position points. Take a series of pictures of this model with each position point as center. Then through the Alpha Channel of Adobe Photoshop transform the silhouette of the object mask (Figure 3). Following the input of D-sculptor, utilize the Boolean Subtraction mentioned in Media Review to speedily produce 3-D models and mapping texture for later matching. Currently, the only matured D-Sculpture technique in the market is produced by D-vw.

Filming Plan and Trackers

With the digital model in place, designers shall plan the range of the site for the model and the shot range to facilitate the actual filming in the future (Figure 4). In addition, as explained in Media Review, Boujou needs a lot of trackers to help with the computation. So after the filming range is determined, designers shall set up trackers on the site before filming, e.g., placing A4 papers on the ground.

5.2 Utilize Boujou to compile

Input the film from Step.2 into Boujou. The software will automatically grab trackers for each frame and through the positioning data of several trackers determine the movement of the 3-D camera. With tracks of movement in place, designers shall delete the trackers that Boujou has automatically grabbed for each frame (Figure 5), leaving only the previously set up trackers on the site to cut down the time needed for inputting the synthetic software to look for positions.

5.3 Synthetic Output of Animated Picture

Synthetic Output of Animated Picture: Input the movement data of the camera into the 3-D Studio MAX and switch the animate background to actual filming. Select Camera01, and the trackers
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Table 1: The compare of Media steps.
previously set up on the site will show the background picture with the sequence frames focused on the background. At this moment, designers can set up a reference plane by using several trackers and incorporating the digital models established in Step 1 into this reference plane, adjusting the proportion and rotation angle (Figure 6). After this is completed, when the designer scrolls the timeline of the animated picture, the model will stick to the site in the background film (Figure 7). When this is verified in the test run, the animated background and the model can be rendered together as a synthesized film through the 3-D Studio MAX (Table 1).

6 Project: ITRIS 2010

The author quickly applied the media steps to an actual project. ITRIS 2010 is a project that constructs the freeform model of digital architecture on the actual site. Due to the fact that the construction of a freeform digital model on the computer is quite difficult, the author pulled out several desired shapes from the clay and through D-Sculptor turned these shapes into digital files and utilized the software to finish the detail. Then via Boujou and 3D Studio Max, the author incorporated these models into films shot from different angles, such as the overall environment, portrayal of the entrance, and view of the pedestrians. Lights and materials were adjusted through MAX to match the conditions of the site. For example, 3 coarse models and 3 background films of the site can be quickly merged into 9 different environmental simulation films of different time and angles. The position of the coarse models can be easily adjusted to match the site for studies and for editing the multimedia film of ITRIS 2010. In ITRIS 2010, these synthesized films show the relations between design works and site dynamically producing lifelike simulation effect (Figure 8). These also demonstrate that the research and methods are reachable, producing a high quality presentation film that designers have never seen (Tang 2002).

Figure 8. Camera-matching technique apply to ITRIS 2010
7  Application
As the outcome of the project indicates, this media research intends to incorporate recent technologies of the other domains to enable designers to effectively study their ideas within a short period of time and render presentations that are as good as commercial films. Due to the fact that the simple procedures proposed in this research, as well as the automatic software it recommends, will greatly reduce the threshold of applying technologies of other fields to architectural design, small-to-medium-size architectural firms will be freed from the restrictions of budget and facility and will be able to swiftly demonstrate design concepts and how the model fits into its site through synthesized films of various angles.

There are two restrictions to be resolved: The Boolean subtraction of D-Sculptor is unable to effectively render the dent faces of the model, and as a result there are flaws in the pasting process. In addition, currently Boujou is still not capable of performing automatic computation for the zooming shot of the camera. Pictures can only be taken through fixed focus, and the variety of shots is consequently reduced. Further study could orient to developing real-time synthesize technique of interactive panorama environment (Scenewe@ver, 2001) to lead the standstill situation of environment simulation in the design domain forward to the much more lifelike reality and rituality combination standard (Lou, 2002).
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