The Use of An Interactive Animation Viewer in Presenting Architectural Design

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ABSTRACT
This paper analyzes the use of a 3D hypermedia system in architectural presentation. It first reviews the current process of using computer animation in architectural presentation and identifies problems in the current process. The research assumes that a new approach using the hyper-model environment and animation together would provide a better environment for presenting architectural animation. An interactive animation viewer is designed and developed using the new approach. A sample architectural animation is presented using a tape-recorded animation player, a normal animation player, the interactive animation viewer, and a real-time animation player. The analysis of the result is made by a comparison in terms of image quality, speed, user interactions, object hyperlinkage, scene complexity, and information transmission on using different systems in presenting the same material. A conclusion is drawn to show the advantages of using the new approach. Limitations on using the new approach are identified too.

1 INTRODUCTION
The use of a computer generated animation to present an architectural design idea to clients or to the general public is becoming a popular tool in the architectural field. In general, with the help of computer animation, architectural design concepts can be communicated and presented more easily to others who may not have an arcane knowledge of blueprints or other conventional methods of architectural representation. Animation is an increasingly important design analysis tool for architects. The current mode of presenting computer animation needs to be extended in order to permit interactive design decisions. This computer animation is derived from advanced 3D modeling techniques which allow near realistic rendering, texturing and lighting simulations. Sometimes camera movements in an animation are moving so fast that they do not present analysis in any meaningful way. As the animation is shown sequentially on a TV monitor there may be a need to rewind and play back the animation several times before it is fully understood or can be analyzed. As most video players are not frame-accurate it is also difficult to specify a given segment of an animation and this capability is essential for the study of specific design issues. Moreover, as any interpolated frame of the animation may present a design alternative in the context of animating position, shape, material variables or a perspective with design evaluation characteristics, it is advantageous to link any animation’s frame to its original 3D scene.
This paper introduces an innovative mechanism in hyper-linking an animation’s images to other digital media information such as text, audio, images, 2D drawings, 3D models as well as other animation through a “hyper-animation” environment. It shows what an interactive animation viewer is and how it impacts on the presentation of architectural information to an audience. The interaction and feedback issues from the audience are highlighted. The pros and cons of using the interactive animation viewer are also summarized. Its aims are to further enhance the process of presenting computer generated animation in architectural reviews and to extend the hypertext concept to animation. It proposes new interactions on examining and reviewing animation in order to test a design, limit design errors and locate the best possible solution to a given design problem.

2 THE USE OF “FLY-THROUGH” ANIMATION IN ARCHITECTURE

“Fly-through” animation, used in the design and construction phases of a project for studying event graphics and camera angles, is becoming more and more popular in architecture. There are a number of advantages of using animation in architecture. Most clients cannot derive a good sense of scale from blueprints and animation makes it easier to communicate and present architectural design concepts. Through the process of animation, architectural projects can be sold on a conceptual level before committing major resources for engineering analysis and detailed design. With careful planning and design, animation can describe visitor and user experiences, in terms of spaces and design forms, to potential patrons and future occupants of a new building.

Moreover, Burden (1984) indicated that animation can be shared with clients, who may be a thousands miles away, without bulky transportation and these presentations allow clients to see how the building works at eye level and from all angles. Brown (1995) showed that animation can allow parties to test a design, limit design errors and locate the best possible design before construction. He also stated that animation can function as a design analysis tool which permits interactive and immediate design decision making. Where environmental impact and public acceptance are concerned, Day (1994) demonstrated that animation can show how a new building would look with landscaping in place and can open up the planning process to public scrutiny. These preview abilities allowed strategies for the future to be judged more effectively.

On the other hand, Mark (1991) argued that animation may not have the capacity to convey the precise arrangement of objects within a scene. He stated that it may require a combined used of both animation and plan representations to provide a complete representation of an architectural space. In addition, camera movements in an animation were sometimes moving so fast that the animation could not be analyzed in an unhurried way. Sometimes, it may need to rewind and play back the animation several times before the animation could be fully understood. Even if a segment of
the animation was particularly useful for studying specific design issues, it was difficult to specify the segment for playback and analysis.

As most animation were shown sequentially on a television monitor, the current method of presenting them may need to be extended in order to examine and discuss the specific features of the animation. This extended method should solve questions such as whether an animation can clearly present architectural design concepts to the audience and whether an animation is more persuasive than conventional modes of imagery.

3 THE INTRODUCTION OF A “HYPER-ANIMATION” ENVIRONMENT

This paper argues that animation should be stored on disk and be displayed in sequence at a rapid rate from disk through an animation viewer’s window. The interface of the animation viewer should allow precise control of playback speed, inspection of single frames, and forward or backward movement.

It would also be advantageous to link any frame of an animation to its original 3D scene. Mitchell (1991) showed that any interpolated frame of an animation may present a design alternative in the context of animating position, shape, and material variables or may present a perspective with design evaluation values.

Besides using animation, Mark (1991) found that architects generally need traditional plans, sections and elevation drawings so that they can totally identify the boundaries and scale of an architectural space; the objects within the architectural space and the relationship of objects within the architectural space.

This paper thus introduces a “hyper-animation” environment, which makes use of a hyper-model environment in animation playback. The hyper-animation environment allows users to select objects from any frames of an animation through a background hyper-model environment. It also allows users to study any segment of an animation in detail. This research anticipates that the hyper-animation environment can provide a better methodology for presenting computer animation as a working tool for architects.

4 AN INTERACTIVE ANIMATION VIEWER

Using the approach of the hyper-animation environment, an interactive animation viewer is programmed, as illustrated in Figure 1, with the capabilities of random access to the animation’s frames by use of a slider control, in-point and out-point settings for repeated segment playback, and frame-based perspective-linkages and hyper-linkages to 3D object. The random access capability provides an opportunity for the audience to criticize and examine the content of an animation on a frame-by-frame basis. If the audience are impressed by a segment of frames which are
particular useful for studying a specific design issue such as an experience of approaching a building, they can set in-point for the beginning of the segment and out-point for the end. With a click on the repeat button, the audience can review the segment repeatedly. A particular frame of the animation may contain critical information such as a spectacular perspective, an interesting design element which deserves further elaboration, or even a possible design error. The audience can stop at that frame and open a 3D scene viewer using the same perspective as that shown in that frame. If the audience clicks a point on the animation viewer’s window, the object hit by projecting a light ray from the clicked point to the 3D scene is located. The audience can then be presented with information associated with that object, in the form of a plan, elevation, section, or textural description, for further study.

![Image](image.png)

Figure 1: The programmed interactive animation viewer

4.1 The Development Information of the Interactive Animation Viewer

This software development is programmed in C++ utilizing the toolkit of IRIS Digital Development Option, Motif and IRIS Inventor. The details of the development are as follows:

4.1.1 The Digital Animation Decoding

The decoding process of an compressed digital animation is handled by the IRIS Digital Development Option. The animation’s compression schemes supported by the interactive animation viewer are those supported by the IRIS Digital Development Option. It includes “none” for no compression, “mve1” for an Silicon Graphics (SGI)
video compression scheme, “mve2” for another SGI video compression scheme with slower but greater compression and faster decompression than “mve1”, “jpeg” for standard JPEG compression, “rle” for 8-bit run-length encoding, and “rle24” for 24-bit run-length encoding.

4.1.2 The Animation Viewer’s Interactions

Motif is used to display buttons for repeat, play, stop, forward, backward, first frame, last frame functions and to display a slider for random access to any frame in an animation. As the animation is generated by the computer, its 3D scene geometric file and its associated camera information can be stored initially in a file. A IRIS Inventor module is programmed to link the saved camera information with the corresponding animation’s frame, as illustrated in Figure 2. The module can locate the selected object in the 3D scene by back-raytracing the point clicked in the animation viewer window. The activation of hypermedia information like 3D models, 2D drawings, images, text and audio is also handled by the module.

![Figure 2: A bubble diagram illustrating the hyper-animation environment](image)

With these new capabilities of the interactive animation viewer, architectural design concepts encoded in an animation can be examined and reviewed in an innovative manner. The differences in using the interactive animation viewer, a recorded animation playback, a normal stored animation viewer and a real-time animation viewer are shown in the following section.
A sample computer animation, as illustrated in Figure 3, submitted for an architectural design competition by the Department of Architecture, The University of Hong Kong, is used to analyze the impact of the interactive animation viewer on architectural presentation. The computer animation is about two and a half minutes long and consists of sections of a flying logo, an introduction text description, a site introduction, a site overview, a main passage-road walkthrough, a fly-through towards the main design complex, an eye-level walkthrough in the main design complex with interior views, and a still view of the design complex from day to night transition. The animation is prepared by first modeling 3D objects in AutoCAD and then rendering the animation sections in 3D Studio. The composition of animation sections is done by Wavefront’s Video Composer which adds transition effects from section to section. The animation images are then recorded to a write-once laser disc. Finally, the synchronization of audio with animation images is performed on an analog VHS video recorder by simultaneously transferring animation images and audio from the laser disc player and a CD-audio player respectively.

Figure 3: The sample computer animation

5.1 The Deficiencies of Using a VHS Video Tape for Design Evaluation

The VHS video thus produced is then presented by the use of a television monitor for examination and studying. It is observed that the animation is impressive and the usual reaction is that more than one playback is required. Viewers may require to playback a particular segment for in-depth investigations. With a normal video playback device often the animation has to be recorded several times sequentially in order to avoid time-consuming rewinds. A particular segment cannot be played back instantly as the normal video player cannot specify in-point and out-point and cannot relate the animation content to other information such as plans, sections, elevations or
5.2 The Problems of Using a Normal Animation Viewer

As the animation is first prepared digitally, it is possible for the animation to be displayed by an animation viewer. Currently, there are a number of animation players, supporting different compression schemes such as JPEG, MPEG and RLE. They all can playback a sufficient long animation, which can be as long as a whole video movie but a loss of a certain amount of quality and size of exhibited image are necessary tradeoffs. Most animation viewers provide functions for the audience to play, stop, fast forward, fast backward, one frame forward and one frame backward. However, these interactions are not sufficient for the audience to examine the animation for the purposes of testing a design, limiting design errors and locating the best possible design. For example, in playing back the captioned animation from a stored animation file, viewers may like to review the segment of the main passage-road walkthrough. There is no simple and direct method of locating the segment using the normal animation viewer.

5.3 The Use of the Interactive Animation Viewer

With the interactive animation viewer, the audience can stop at any time and use the slider to drag the display of frames interactively during the playback. The audience can also set the in-point and out-point of any frames for a particular segment manually during the animation playback with the help of the slider.

Moreover if the audience are interested in the form of any one of the newly designed buildings, they can stop the animation playback and click a point on top of the required building. The interactive animation viewer can then identify that building and provide additional hypermedia linkage information to the audience, as illustrated in Figure 4. For example, if when displaying a segment of the site overview, the audience wishes to have more information about one of the complexes in the scene, they can then point the mouse cursor on top of any area within that complex and press a mouse click. The program seeks the background hyper-model environment and locates that particular complex. With that complex there may be a series of hyper-linked multimedia information created during the authoring the process. Normally the hyper-linked multimedia information will be the information contained in the database which is related to that selected complex. The audience can then choose to view any relevant information as wish.
Figure 4: Frame-based hyper-linkage

Figure 5: Frame-based perspective linkage
Alternatively if the audience is interested in one of the perspectives in the animation they can stop the animation at that frame and activate a hyper-perspective button. The program will extract the camera perspective associated with that frame from a table and pass the camera information to a 3D hypermedia paradigm where the audience can view the 3D scene in real time starting with the selected perspective, as illustrated in Figure 5.

5.4 The Alternative of Using Real-Time Animation

The capabilities of random access to an animation's frame, the in-point and out-point settings, and the hyper-frame linkage can also be performed in a real-time animation system, as for example in a virtual reality (VR) system. However, if the 3D scene is more complicated than the one supported by the system, the real-time response of the system is lost and the display of the animation may not be fast enough to give the audience an illusion of smooth motion.

6 ANALYSIS

A comparison of using a video tape player, a normal animation player, an interactive animation viewer, and a real-time animation viewer for examining design concepts through computer animation is made as follows:

<table>
<thead>
<tr>
<th>Presentation elements</th>
<th>Video tape player</th>
<th>Normal animation player</th>
<th>Interactive animation player</th>
<th>Real-time animation viewer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Quality</td>
<td>✓✓</td>
<td>✓</td>
<td>✓</td>
<td>x¹</td>
</tr>
<tr>
<td>Display Speed</td>
<td>✓✓</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>User Interactions</td>
<td>x</td>
<td>✓</td>
<td>✓✓</td>
<td>✓✓</td>
</tr>
<tr>
<td>Object Hyperlinkage</td>
<td>x</td>
<td>x</td>
<td>✓✓</td>
<td>✓✓</td>
</tr>
<tr>
<td>Scene Complexity</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
</tr>
</tbody>
</table>

Remarks: ✓✓ stands for good. ✓ stands for normal. x stands for limited.

6.1 Image Quality

The quality of images displayed from a video tape player is the best as it can show all the digital image qualities generated from any high-end image processing programs

¹ Most real-time rendering is using Gouraud shading, which doesn't have shadow casting and good lighting contrast.
and rendering programs. The quality of images shown on animation players, both normal and interactive, has some trade off because of the compression applied to the animation for ensuring continuous playback. The real-time animation’s images are normally rendered by a hardware graphics engine, which can only support limited shading quality, such as Gouraud shading, currently, and so its quality is a limited, especially related to the issues of surface lighting interpolation and shadow casting. As the technology of hardware improves, the quality of real-time rendered images will become as good as today’s video tape’s images. Although the quality of images in the interactive animation player is not as high as video tape players (because of image compression), the interactive animation player can display complicated scenes, which is commonly required in architecture, and can continuously support a better image quality than that of the real-time animation player.

6.2 Display Speed
The images’ display speed of video tape is normally greater than 25 frames per second. Owing to the bandwidth limitation, most animation players cannot display images as fast as a video tape player even though compression is applied to reduce the size of the image file. The images’ display rate of a real-time animation player depends on the hardware performance. Even with a powerful SGI workstation, a complicated scene like a Chinese Temple cannot be displayed smoothly in real time. With careful selection of an animation compression scheme, an interactive animation player can show computer animation fast enough no matter how complicated the scene is.

6.3 User Interactions
The interactions provided by the interactive animation player can allow audience to perform random access to any frame of animation and to interactively set in/out-points for repeat playback. The system also allows users to locate 3D objects in the scene and share camera information with a real-time 3D model viewer. With a certain amount of programming, a real-time animation player can have the interactions mentioned above as well. The interactions provided by a normal animation player are usually limited as they are designed for general purposes instead of for a particular situation. The interactions provided by a video tape player are the most limited, even if a high-end tape player has a shuttle dial and some precise analog controlling mechanisms. The feasibility of digital controlled interactions is much greater than analog controlled interactions. In examining and reviewing computer animation, users’ interactions provided by an interactive animation player and a real-time animation viewer are required. The interactions provided by a video tape player and a normal animation player are too primitive.
6.4 Object Hyperlinkage

Both a video tape player and a normal animation player can only sequentially display computer animation. With computer software programmed by IRIS Inventor, an interactive animation player can provide object hyperlinkage on a frame-by-frame basis. A similar object hyperlinkage can also be performed in a real-time animation viewer by incorporating the idea of 3D hypermedia.

6.5 Scene Complexity

As the images displayed from a video tape player, a normal animation player, and an interactive animation player are rendered before being displayed, they can be as complicated as those handled by a computer rendering program. In order to render and display images at the same time a real-time animation viewer cannot display too complicated a scene. An interactive animation can display images which are free from any scene complexity limitation.

7 CONCLUSION

In examining and reviewing computer animation, the interactive animation viewer and a real-time animation viewer perform better in terms of interactions and hyperlinkage. With respect to image quality, display speed, and scene complexity, the interactive animation viewer is even more flexible than a real-time animation viewer.

Currently defining an area within a digital picture can activate a link to other multimedia information. For example, by clicking on the area of a building in one picture, users can activate a link to information related to the building. However, if we want to define selection areas in a series of images, which form a continuous animation, we have to define selection areas picture by picture as each selection area may be different from others. This paper eliminates the tedious picture by picture selection areas definition by combining an animation display with a background hyper-model environment. The audience are required only to pick a point in any picture of the animation and the object hit by that point can be selected automatically by storing an additional array of the frame’s camera information.

With the introduction of this hyper-animation environment, architecture design concepts encoded in digital form can be presented and reviewed in an integrated environment instead of as discrete digital information. The hyper-animation environment can maintain the continuity of presentation and provide an interactivity of the hyper-model environment. It offers the feasibility of presenting as a whole or segment by segment.
As the user interacts with the interactive animation viewer an animation can be examined and reviewed by treating the human activity as a dynamic agent which provokes reaction, participation and communication.

8 REFERENCES


