

3D Digital Space and People:

Extents and Limitations of Integrating Human Figures in Architectural Animation

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It is people that make architecture alive. It is motion that captures our attention. Together they make our architectural environment believable. Besides portraying a friendly environment, digital people can portray the best reference for scale, time, location and character of an environment.

Representing architecture along with human figures has always been an integral aspect of architectural representation in traditional media. As we moved from traditional representation to animated 3D digital modeling, representation of people lost its spirit. Perhaps the reason for this is that a great deal of time and energy needed to be dedicated to the development of human figures. In addition, defining movements and poses for each figure requires additional skills. The aim of this paper is to explore the options of simulating people in the context of environmental design as well as to provide simplified techniques for representations of people in 3D digital animation.

Keywords: *3D computer animation, Human figure, Representation*

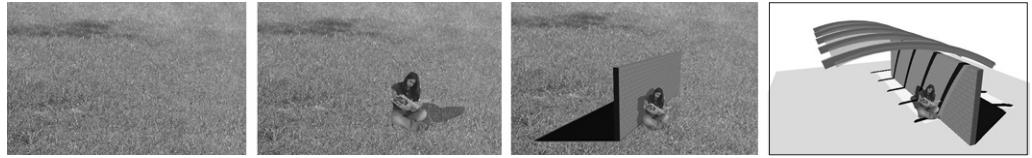
1. Introduction

Space is basically formed by the relationship between an object and a human being who perceives it (Ashihaea, 1970). In exteriors space is created by delimiting nature. In interiors spaces are delimited by three planes: a floor, a wall, and a ceiling.

Space constantly encompasses our being. Through the volume of space, we move, see forms, hear sounds, feel breezes, smell the fragrances of a flower garden in bloom. It is a material substance like wood or stone. Yet it is an inherently formless

vapor. Its visual form, its dimensions and scale, the quality of its light – all of these qualities depend on our perception of the spatial boundaries defined by elements of form. As space begins to be captured, enclosed, molded, and organized by the elements of mass, architecture comes into being (Ching, 1996). Space is created by the interaction of both people and built form. The development of AutoCAD applications followed by other 3D modeling programs has undoubtedly enhanced the representation of

Figure 1
Space formed by the relationship between object and human being.



digital spaces. Further developments of rendering and lighting features in 3D applications have provided options for photo-realistic simulations of interior or exterior spaces that can compete with reality.

But, when it comes to rendering people, there are certain limitations, especially animating human figures. For static 3D architectural renderings, photographs of people can be superimposed over 3D rendered views with accuracy and perfection. For animation, this process gets complicated. Since the camera is moving along its path, and objects are placed in a 3D space, photographs of people will not create the true representation of a 3D person. If the camera direction is not perpendicular to the photograph's plane the figure will become a thin line or a distorted image.

A 3D-modeled, human figure will resolve the issues of inappropriate dimensions and aspects of distortion. Human figures cannot be modeled with simple geometric shapes. Posing animated figures requires character modeling techniques using smooth 3D high-polygon objects. This process demands high computing power as well as high budget. The process of constructing realistic 3D human figures with

believable details becomes very time consuming and labor intensive. Creating correct movement of body parts and gesture expressions also require talent and special artistic skills. This paper demonstrates some primary means of creating people in a digital 3D animated environment that are cost effective and appropriate for architectural animation.

2. Static People in Animated Space

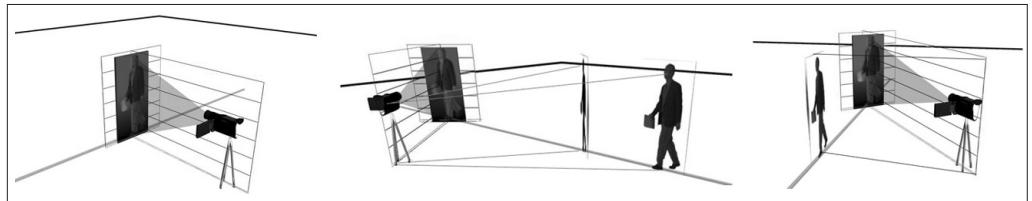
It is possible to use photographs of people in an animated environment. The process is similar to superimposing an image of a person in a 2D image-editing program. Since these images are non-animated human figures it is best to place them in the background or behind larger objects.

To place such figures in an animated environment is quite simple. First, a two-dimensional rectangle of appropriate height is created in the 3D modeling program where the image of the person will be pasted. Then the image is placed as a texture map with the background being transparent. Since this image is placed in a 3D modeling environment, the depth in perspective would be adjusted automatically with the movement of the camera. Foreground and background objects will appear in correct sequence. One important consideration in this technique is to keep all image planes (human figures) perpendicular to the camera view.

Figure 2
Two-dimensional images of people superimposed over 3D rendered images.



Figure 3
Image plane perpendicular to the camera view.



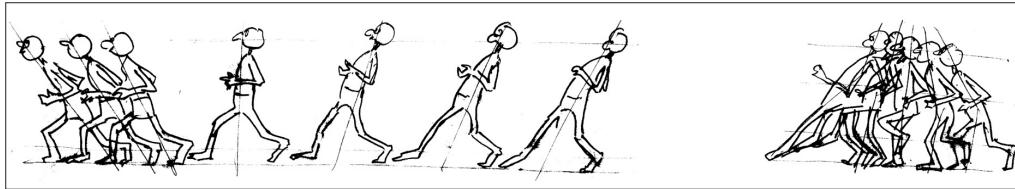


Figure 4
Animation with sequence of
line drawn figures.

3. Animated People in Line Drawing

This technique involves integration of two-dimensional animation of line-drawn figures in a three-dimensional animated model. Depending on the nature of the modeled space, this integration can be either in the modeled environment or in a video-editing environment. In the model environment, the human figure animation needs to be on a plane that would be placed perpendicular to the camera view. In a video editing program, animation of the human figure is superimposed as an additional two-dimensional layer.

To create a good animation with hand drawing skills in art is needed. Creating appropriate movement style also requires experience in hand drawn animation. The end result of such a technique would provide a combination of hand-rendered entourage and machine-created 3D rendered environments.

4. 3D Low-polygon Models

The most popular 3D low-polygon human figure application is Character Studio by Discreet. To animate a 3D humanoid-type character, this application uses the concept of a bone structure that controls the surface of a mesh. Character Studio is a plug-in program that runs inside 3D Studio Max. The application is mainly used to animate a 2-legged character that is created in a modeling application. The Character Studio program has two main elements to it: the Biped which generates a humanoid template that someone can animate, and the Physique which links the mesh to the Biped. Character Studio has built-in walk, run and jump movements that can be applied to a character.

For proper movement of body parts, the application uses a system called Inverse Kinematics. It calculates the position and orientation of objects in a kinematic chain. The kinematic chain is defined as a single branch of the hierarchy that starts with a selected child object and continues up through its ancestors until it reaches the base of the chain. The base of the chain is either the root of the entire hierarchy or an object that can be specified as a terminator for the chain.

Using inverse kinematics requires set parameters for a number of Inverse Kinematics components. Brief definitions of these components and main steps to create a low polygon animated figure are:

- Creating a Biped
- Adjusting a biped to fit a mesh
- Using figure mode
- Using Physique to link a mesh to a biped
- Animate the character

Although the process of low-polygon animated figures seems simple at the beginning, it does require extensive manipulation of the software features to

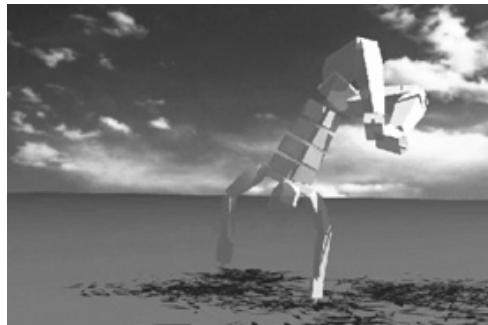
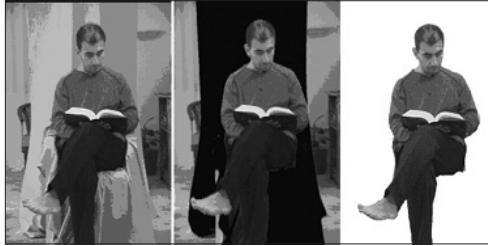


Figure 5
Movement of body parts with
Inverse Kinematics process.

Figure 6
Green screen masked and removed in video editing application (Premiere, or After Effects).



create desired effects. For example, stretching the skin of a mesh and deforming the mesh to give the right appearance of muscle bulging will require skill in understanding the software features.

Since these figures are actual 3D objects, they can be moved along their own path without being effected by the movement of the camera direction. It needs to be noted that modeled people can never truly simulate natural movements of a person in reality, and thus will reveal the synthetic quality.

5. Superimposition and Color Deletion Technique

This technique is often seen in Hollywood's high-budgeted films, where footage of real actors in a studio environment is superimposed with a different background, and where the actor cannot be present or the environment is yet to be found. Although usage of this technique is rare for architectural walkthrough animation, a simplified version could become cost effective as well as useful.

In this technique, video footage of walking or standing people shot against a single-colored background is superimposed over a 3D modeled animation. Video clips are then converted to sequential alpha channel images to make the single color background transparent.

There are a few companies that provide sequential alpha channeled people libraries for using in animations and films. Also, there are software plug-in based solutions that work in conjunction with selected 3D modeling and animation software.

6. Process of Integrating Moving Human Figures in 3D Animation

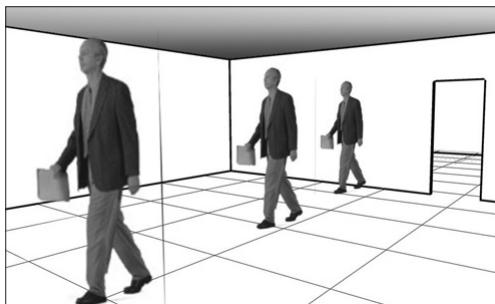
We experimented with green screen technique in our digital design studio to review results without special equipment. First, we purchased 20 yards of low-cost blue cotton fabric from Wal-Mart (\$1.87 per yard). We used our usual room lights for video shooting. After the shoot we noticed that some parts of the blue fabric became darkened since the lighting condition was not evenly distributed. When removing blue from the background during the video editing session, portions of our character's black hair and eyes were also removed. Their colors matched with the dark spots of the blue fabric. For better results, instead of adjusting the lights, we switched the color of fabric to neon green (\$2.67 per yard). As a matter of fact none of the areas of neon green got darker with our room lighting conditions.

A Canon GL1 Mini DV camcorder was used to get our shots. But this experimentation could be done with any Mini Digital Video (DV) camcorder to get decent results. After shooting our character, we transferred the video to our computer and removed the green screen background using Adobe Premier 6.5. We saved our character in image sequences both in color and alpha channels.

There are two types of animated people to be considered. The first type would involve doing gestures, reading, speaking, etc., and not actual walking. The other type would incorporate features of walking, moving, running, and other movements.

The first type of animated people is simple to record and also quite easy to place into an animation. Since, there is no need to assign a motion path to the character, just adjusting the objects height and perspective to the camera is enough to get a decent result. The final layering of people over an architectural animation can be done by either with a 3D software (3D StudioMax) or a video editing software (Adobe After Effects, Premiere).

The second type of animated people needs various adjustments during the integration of video footage



and digital animation. The first thing that needs to be considered is the motion path of a character. It has to match with the architectural walkthrough animation according to perspective rules. This is because the person originally shot may have a different preset camera angle, and could appear distorted.

The character has to be observed at the same camera angle that would match with the camera angle of the walk-through. Another option would be to insert the character to the far background of the scene if possible. After adjusting the person's motion path, the right number of steps must be calculated for specific distances, to create a normal walk mode.

Assuming that a normal person walks 3 miles (5 km.) an hour, we calculated that 4'-7" (1.40 m) would be covered in one second. This means the walking figure has to travel 4'-7" in 30 frames. This calculation is helpful in understanding how to create a motion path in 3D StudioMax or in other 3D software envi-

ronments.

The best representation technique of moving people could be achieved by creating an illusion using pictures of a person shot in sequence from all angles. In order to create a 3D-animated video character, roughly 90 sequenced images are necessary. The images should be sequenced with the numbers incrementing, turning counter-clockwise in direction. Two separate image sequences are needed, one for color, and the other for alpha sequences of the same image. They should be saved as Jpeg images. A third image is needed as a preview image. To create effective results, this image should be 124x98 pixels and saved as an RGB 24 bit bitmap file.

The specific advantage of this last method is in its representation of three-dimensionality. Since there are enough rotational images to create the illusion of three-dimension, the camera can be in any location to render good 3D people. Although in this process the moving person is not completely camera dependent, the illusion of 3D can suffer if the camera is elevated 40-degrees above the normal eye level.

7. Conclusion

The purpose of this paper is to examine the options of integrating moving people into an architectural animation. Although a number of options are possible to incorporate in an architectural animation, this paper finds video footage integration is more effec-

Figure 7
Height and perspective to the camera is important to match final animation.

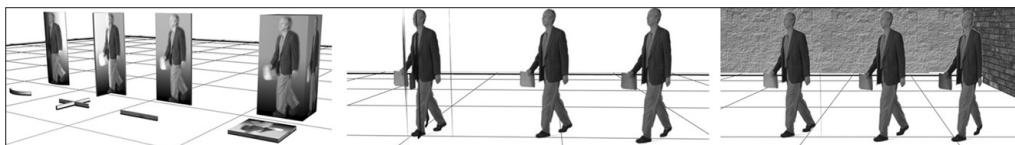


Figure 8
Alpha-channeled people on a path and matched with perspective.

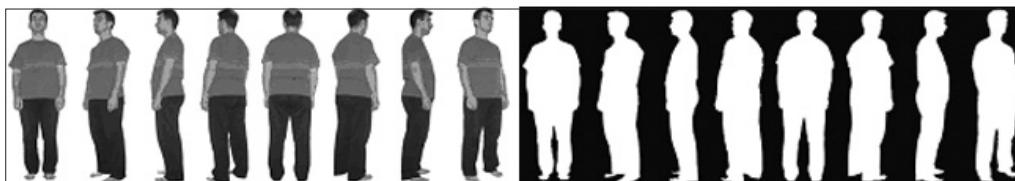


Figure 9
Colored and alpha channeled image sequences using nine turns.

tive and true to a realistic architectural environment. 3D low-polygon modeling techniques are effective if time is spent to learn skinning techniques and inverse kinematics processes within the required application. Effects of this modeling technique are to create synthetic people with correct shades and shadows. Line drawn movement of human figures are appropriate for schematic 3D models, rather than photo-realistic architectural animation.