Caricaturing Buildings for Effective Visualization

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In this paper, we show that the concepts of abstraction, simplification and exaggeration, which are very common in traditional art and caricature, can directly be applied to the 3D architectural visualization and modeling for interactive media applications and effective visualization.

Keywords: *3D Modeling, Visualization, Caricatures*

Introduction

Being an extremely visual profession, Architecture is bounded to visual arts like painting, graphic design and visual communication. Recent developments in interactive media applications also influence architects and visual designers to create new ways of representations of the built environments and architectural landmarks. However, it is a challenging process to communicate with non-designers and public.

3D interactive visualizations of built environments, environmental visualizations, are very useful for a large variety of applications that helps architects to communicate with non-designers and public. Environmental visualizations can show well-known landmarks and architectural heritages of cities. They can help the public understand the cultural influences and history that makes a city unique.

Environmental visualizations require the development of 3D computer graphics representations of most of the existing built structures in the modeled environment. In practical applications these representations must be extremely simplified versions of actual buildings; the interactive speed of computer visualizations greatly depends on reducing the complexity of modeled environments. In other words, the designers must not try to model every detail present on the built structures existing in reality. However, this is not an easy problem to solve. They cannot simply design “a box”, by ignoring all the characteristic features. Thus, the important question is: how do we identify characteristic features of a built structure that makes a particular structure unique?

Unfortunately, current visualization practices do not provide a satisfactory answer to this problem. The common practice is to emphasize photo-realism in both modeling and rendering. Although none of the 3D computer representations can be truly accurate, the concept of photo-realism forces the designers to create reconstructions as detailed as possible.

Such unrealistic expectations never existed in traditional arts. No painter will draw every visible detail in a still life. Artists frequently ignore unnecessary details and focus on the characteristic features of their subjects. Such selective representations are most noticeable in the works of caricaturists and cartoonists. They not only ignore unimportant details, but

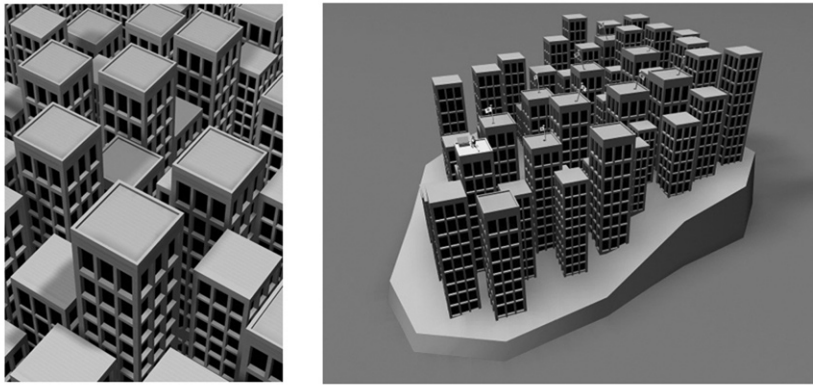

Figure 1
Two views of 3D computer generated buildings that are inspired by cartoons of Guillermo Mordillo.

also selectively exaggerate the features that make their subjects unique. They do not only exaggerate faces of the people. They exaggerate and simplify all of their subjects. For instance, a building in a Mordillo cartoon is always extremely simple but still instantly recognizable.

The concepts of abstraction, simplification and exaggeration, which are very common in traditional art and caricature, can directly be applied to the Architectural 3D modeling process. Such abstraction, simplifications and exaggerations can provide the means to create public-friendly interactive visualizations of built environments.

Therefore, the development of methods to apply these concepts is essential for 3D architectural modeling. It is also important to teach these methods in computer aided architecture and design education. In this work, we present a method that can be used in abstraction, simplification and exaggeration of buildings. Our method can also be used to teach students these artistic concepts by modeling expressive 3D building caricatures.

Previous Work

Creation of effective 3D computer representations of built environment has always been important for architectural visualization. We propose that caricature principles of simplification and exaggeration can be useful tools for architectural profession to create effective visual representations. Such simplifications and exaggerations are, in fact, very common in different art disciplines. For instance, no painter will draw every visible detail in a still life. Artists frequently ignore unnecessary details and focus on the characteristic features of their subjects. Such selective representations are most noticeable in the works of caricaturists and cartoonists. They not only ignore unimportant details, but also selectively exaggerate the features that make their subjects unique. They do not only exaggerate faces of the people. They exaggerate and simplify all of their subjects. For instance, a building in a cartoon is always extremely simple but still instantly recognizable as familiar skyscraper as shown in Figure 1. Another important characteristic of pictorial maps is that in pictorial maps 3D views do not have to be perspectively correct. In fact, most of pictorial maps do not use correct perspective transformation and exaggerate important buildings or landmarks.

Classical caricaturing processes do not provide enough clues for caricaturing buildings. Except cartoonists such as Guillermo Mordillo and Saul Steinberg, classical caricaturists work mostly on human beings and they focus mainly to the faces. Similarly, computer graphics research on caricature mainly focuses on caricaturing faces and most of the existing work involves with 2D caricatures (Akleman

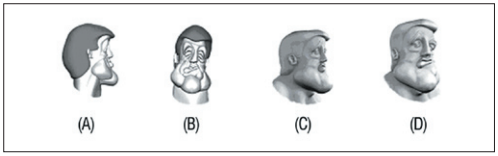

Figure 2
Sylvester Stallone by Jacob Brooks created using Akleman-Reisch method. (A) and (B) show modeling with disconnected pieces. (C) and (D) show final 3D caricature.

1997, Akleman et al. 2000, Brennan 1999). Skaria et al. developed a user interface to create 3D cartoon faces (Skaria et al. 2001) but cartoon faces are not exactly the same as caricature faces. In the former abstraction is more important, on the other hand, in the later the recognizability is important.

Akleman and Reisch recently developed a method to model expressive 3D facial caricatures (Akleman and Reisch 2004). Akleman used this method to teach students the caricature concepts, abstraction, simplification and exaggeration, by modeling expressive 3D facial caricatures. This method has been successfully used in a geometric modeling course that combines artistic and scientific aspects of 3D modeling. In Akleman-Reisch method, caricaturing faces is a process that consists of four stages: (1) Data collection; (2) Unique (Exaggerated) Feature Identification. (3) Abstract Caricature Creation and (4) Final Modeling and Rendering . Using the method, all the students, regardless of their artistic abilities, can create convincing 3D caricatures. Figures 2 shows an example created by a student.

Methodology

In this paper, we present an expressive modeling approach based on techniques of caricature and cartoon art. Using available 3D modeling software, this approach can be used by virtual designers to recreate simplified computer generated models of existing buildings. It can also help to limit modeling time and helps to easily reconstruct recognizable landmark buildings for pictorial maps of college campuses, cities, and regions. Such pictorial maps can be very helpful in route finding, travel planning and public presentations.

Caricaturing buildings, although has some similarities with caricaturing faces, is different than face caricatures. Faces, unlike buildings, are topologically the same. Everybody has the same number of noses, eyes and ears. Therefore, exaggeration of faces can simply be obtained by a deformation that does not change the topology. However, the natural and built structures are topologically very different. Each building can have a different number of features, e.g. different number of windows, columns and doors. Therefore, in order to exaggerate the features of buildings, we not only have to change feature sizes but also have to change their numbers. For example, we have to change the number of windows for exaggeration.

Because of these differences, Akleman-Reisch method cannot directly be applied caricaturing

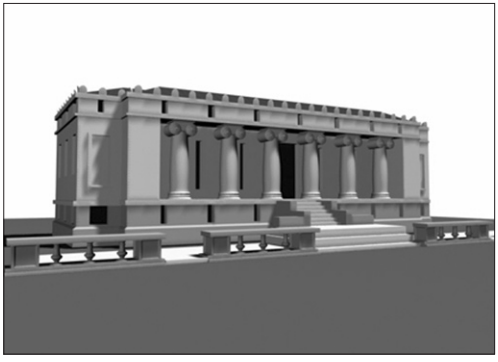

Figure 3
(a) is the Administration building at Texas A&M University, College Station, Texas and (b) is its extremely exaggerated caricature. Although, the number of columns and windows are very different from the original building, people do not perceive the differences unless they are shown next to each other.

buildings. Therefore, we have extended Akleman-Reisch method to develop a method for abstraction, simplification and exaggeration of natural and built structures without losing their personality and characteristics. The Figure 4 shows an example of simplified and exaggerated buildings that are used in interative visualizations. Since, we significantly reduce the number of columns, windows, and doors, our 3D models are extremely simple and allow interactive visualization.

Our approach begins with a determination of the minimum, acceptable number of architectural details that must be represented in 3D computer generated models. This process relies on caricature drawing techniques to choose which architectural details should be added or subtracted to limit the amount of time and data in the modeling process. We include a number of examples, some by students that demonstrate the results of this process. Similar to Akleman-Reisch method (Akleman and Reisch 2004), our method for caricaturing buildings is a process that consists of four stages:

Data collection

In this stage, we choose a locally, nationally or internationally well-known building with an easily recognizable shape. For caricatures, we usually use either local buildings or very well known landmarks. During this stage, we take photographs of local buildings and collect photographs of well-known landmarks from a wide variety of sources such as internet or architectural journals.

Unique (to be exaggerated) Feature Identification

A feature of a face is called unique if it is different than average. In Akleman-Reisch method, identification of the unique features is essential for creating caricatures since those features are the ones that will eventually be exaggerated. Students identify the unique features of a given face by using a procedure developed by Akleman (Akleman 1997). The procedure based on the image morphing consists of four stages.

1. Start with a representative image of the person
2. Create an very simple template for image morphing
3. Exaggerate only one feature at a time. If exaggeration creates a likeness, continue to exaggerate. If it does not create a likeness, make the exaggeration in the opposite direction. If neither direction gives a likeness, return the feature to its original position.
4. Continue with another feature until all unique features are identified.

Since there are only a few numbers of features in faces (such as distance between upper lips and nose or size of the nose) this process can be completed in a few numbers of iterations. Unfortunately, there are three problems with buildings.

1. The building features are not as well defined as face features. For instance, a feature of a building can be its extremely simplified version. However, extreme simplification is not a well-defined concept. Each designer can interpret it differently.
2. The numbers of features are not limited. Anything that makes a building interesting can be considered a feature.
3. The concept of average is not well-defined in buildings. Columns are definitely features, but, most buildings do not have columns. As a result, we cannot really talk about columns that are above average or below average. In fact, just having columns can automatically be considered as a unique feature.

As a result of these problems, unique feature identification for buildings greatly depends on designer's ability. The process is roughly is the following:

1. Start with a simple representative shape of the building
2. Add a feature (columns, windows, doors etc.) to

the simple shape

3. Exaggerate the feature at a time by changing the size or number
   If exaggeration creates a likeness, continue to exaggerate.
4. If it does not create a likeness, make the exaggeration in the opposite direction.
   If neither direction gives a likeness, delete the feature.
5. Continue with another feature until all unique features are identified.

Abstract Caricature Creation

In this stage, we create abstract caricatures using all features as disconnected pieces. Using disconnected pieces is partly motivated by cubist sculptures such as Pablo Picasso's {Reclining Bather}. Individual pieces also allow faster shape modification. Each unique feature is represented by at least one disconnected 3D surface. Therefore, it is easy to improve 3D recognizability of the caricature shapes by changing the position, shape and size of each feature. As a side note: In both cases, disconnected pieces are modeled by using polygonal meshes.

Final Modeling and Rendering

Once the shape that is constructed with disconnected pieces is confirmed to be a likeness of the building, we create final surface that closely approximates the confirmed shape. In order to render our caricatures, we have developed an Ambient Occlusion shader for Maya, using C++ and the Maya API. The Ambient Occlusion shader reinforces areas of subtle relief on the models and provides a clean, consistent look to the final images. We only use limited amount of textures and colors to ensure that the shapes alone provide the recognizability of the caricature.

Implementation and Results

We use the building caricatures in interactive visualizations, mostly, interactive pictorial maps. The simplicity of these caricatures allows interactive viewing of pictorial maps in internet. The Figure 6 shows a caricature of Coliseum in Rome. We have also created a wide range of caricatures of landmark buildings such as Notre Dame and Hagia Sophia. Some of the interactive visualizations are available in the web page www-viz.tamu.edu/faculty/ergun/ipm/index.html.

Conclusions

Our 3D caricature modeling approach will allow virtual designers to recreate built structures more quickly and efficiently, saving time, money and data resources in the early stages of the design process. Similarly, cartographers and geographers will be able to use our caricature process to rapidly popu-

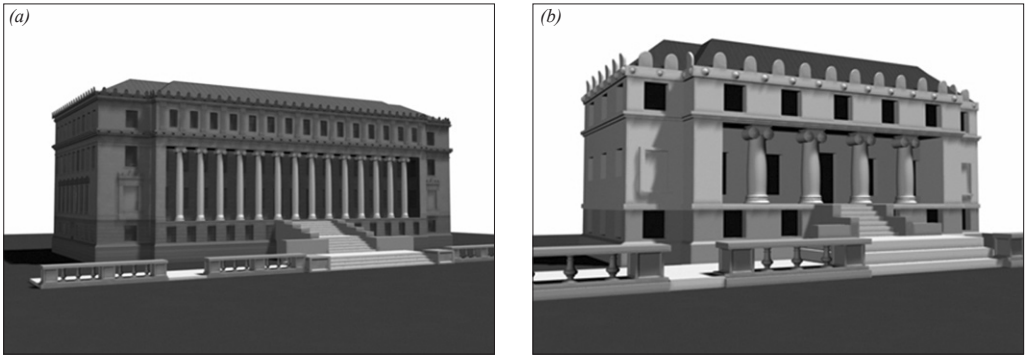

Figure 4
Byproducts that are created in the process of caricaturing the Administration building in Figure 4. (a) is the realistic model and (b) is an exaggeration in the wrong direction.

late pictorial maps, large city plans, college campus maps, and 3D computer visualizations with recognizable built structures. Our building caricature process can be used for early design development and rough 3D sketches to explore ideas. Professional designers will be able to use available 3D software to explore design ideas rather than just using it for the final design presentation.

Our approach allows modeled structures to be rapidly updated and replaced in 2D or 3D mapping environments with many built structures. These 3D representations can also be used to create large city maps, college campuses, pictorial maps, and other computer generated visualizations of built environments. Since our caricature-modeled buildings are closer to the actual mental image of the structures, they are more easily recognized. Our process will allow design professionals to use 3D software in the early stages of development rather than just for the final presentation.

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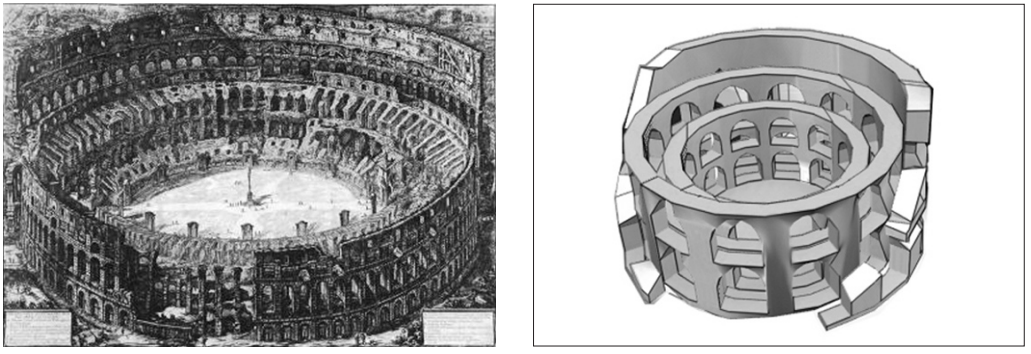

Figure 5
An example of caricature building (A) is realistic rendering of the original (B) is a caricature.