DIGITAL MANGA VIRTUAL ENVIRONMENT

Bi-tonal visualisation for texture-mapped virtual environments

MARC A. SCHNABEL AND YINGGE QU
School of Architecture, Chinese University of Hong Kong, Hong Kong
marcaurel@cuhk.edu.hk

Abstract. Bi-tonal and non-photorealistic architectural depictions can be employed to develop a narrative that engages the reader with not only the visual aspects, but also aspects of the storyline. Architecture is subsequently not only represented through its factual dimensions of length, width and height, but is extended to intangible realms. This paper presents a modified rendering appearance of the graphical depiction of a Virtual Environments (VE) -software to communicate design akin to Japanese cartoon (manga) depictions whereby we expand the two-dimensional manga-images into a three-dimensional VE. The modified visualisation can be used for storytelling and developing a narrative that professionals and laypersons alike easily can access, understand and interact. The bi-tonal depictions offer users to experience both, visual richness of the original model, as well as enhanced design communications.

Keywords. Digital manga; virtual environments; architectural depiction; visual communication.

1. Introduction
Digitally generated, bi-tonal, non-photorealistic depictions are increasingly becoming popular around the world because of its distinct graphical quality with its elegant use of rich set of screens, tidy and fine drawing styles of a black and white (b/w) drawings, and its engaging way of storytelling. This method of visual communication provides another realm for representing drawings, photography, or architectural design being real or virtual. Although conventional architectural drafting depend on pure b/w patterns and lines, or is in other words bi-tonal represented, they lack of personal engagement and
legibility by non-professionals. In a sketch however, it is possible to perceive
the variety of textures and lines as elements of a building or details such as
materials or surface textures by using this non-photorealistic rendering style.
For example, in popular Japanese comics –manga– the artists lay multifarious
screens to express different semantics. Hatches are selected not solely accord-
ing to the shading, or tone, but also according to texture, material property,
chromaticity or even function of the underlying design or architecture that is
being depicted and expressed.

The graphical depiction of three-dimensional Virtual Environments (VE)
mostly presents the user with a more or less photo-realistic chromatic depic-
tion of its scenes. These depictions lack of the artistic qualities of sketches
and often have a dry and sterile look and feel of their interface (see Figures 3
and 5). In this paper, we present a novel method how a bi-tonal non-photore-
alistic rendering can be used to develop narratives akin to manga in order to
experience both, visual richness of the original architectural model, as well as
enhanced design communications and engagement of the storyline.

2. Digital bi-tonal architectural depiction

Architectural drawings and sketches are a universal convention that uses
symbols, screens, hatches, line-types, -styles and -widths to describe (ele-
ments of) a design, its properties, functions or materials (Figure 1). They are
filled with represented knowledge and key information for a specific composi-
tion. In addition to that, architectural drawings are flexible and allow the crea-
tivity of individual architects to influence the overall style of the screens and
impression of the design. In contrast to this, Computer Aided Architectural
Drafting (CAAD) typically has no personal style and depicts neutrally norms
of the architectural, engineering and construction (AEC) industries (Figure 2).
Gross’s (1996) development of an Electronic Cocktail Napkin identified the
need to create digital drawings that can be ambiguous and imprecise; yet they
have to be precise enough that they can be computed and identified.

Figure 1. Gordon Strong Automobile Objective and Planetarium;
sketch by Frank Lloyd Wright.
A straightforward way to produce computational bi-tonal images from grey-scale/colour photographs is halftoning. It exploits the spatial integration of human vision to approximate the intensity over a small local region with only b/w pixels (Floyd and Steinberg 1974, Jarvis et al. 1976, Knuth 1987, Ulichney 1987).

Another technique is hatching to produce bi-tonal images. Winkenbach et al. (1994) generated pen-and-ink illustrations by rendering a geometric scene with prioritised stroke textures.

Images generated by halftoning and hatching, containing more or less uniform patterns that may appear monotonous to the reader; conventional manga instead uses a wide variety of screens to enrich the viewing experience. Qu et al. (2008) describes in detail the technical aspects of their computational manga screening tool that utilises the variety of pattern to preserve the chromaticity distinguishability as well as the tone and texture similarities. Based on their work, we proposed to develop their system to generate manga style architectural drawings including screening, line drawings, and the final rendering (Schnabel and Qu 2011).

Goldschmidt (1991) argues that the architectural sketch is a mode of visual thinking and communication, which is crucial to a conceptual framework of the depicted architectural design. Despite the advancement of digital media, there remains a certain quality of a hand drawing and therefore the architectural sketch remains an important medium of designing, communicating and construing. It incorporates abstraction, fuzziness as well as clarity and sharpness. As that, the expressions of lines and hatches themselves become the objects of meaning and interpretation, a sketch explores from overall relationships to fine resolution of detailed attributes of the depicted design. In order to make the communication of space more precise the drawing makes use of graphic modifiers to convey information that go beyond the pure outlines or
dimensions of the spatial arrangement (Robbins 1994), which are also the underlying principles of manga drawings.

3. Visualisation in virtual environments

With the advent of VE, they are extensively used to visualise, simulate and communicate architectural and urban scenarios. El Araby and Okiel (2003) state that “the importance of environmental simulation is being crucial for almost all environmental design professions for presenting simulations of reality to the observer to predict his responses of the real situation.” In this context, according to McKechnie (1977), simulation techniques are critical to decision-making processes of designers as well as their communication of their design proposals. Yet, conventional depiction techniques were often criticised as they lack some important features that affect their reliability in depicting the real environment, such as the depth of visual field and passive interactivity, while at the same time VE lack on artistic expressions that appeal to a wider spectrum as sketches would do. Subsequently our research aims to intersect sketching with VE to address some of these issues and develop a novel realm and visual communication.

For our research, we chose a typical VE software - UC-Win/Road (http://www.forum8.co.jp/english/uc-win/ucwin-road-e1.htm) by forum8 (http://www.forum8.com) - that is used for interactive virtual reality modelling and simulation for construction, planning, designing and visualisation (Figure 3). It is a tool for project visualisation and consensus building for almost any type of urban project. The software is also used extensively to present and communicate design proposals to laypersons and to visualise simulations and various planning scenarios. The look and feel however, is akin to typical many VE: technical and quasi realistic. This representation deemed to us as ideal test environment to explore the impact and the resulting possibilities bi-tonal non-photorealistic visualisation. Akin to Brown (2001), these visualisations are generated to be different from reality and aid critical design discussions.
Hereby the visualisation acts as mediator and visual clues in the storytelling of design and planning proposals. The software relies on 2D textures that are mapped onto geometries of objects and 3D models. In order to change the visual appearance of the model, we will replace the original textures with ‘mangarised’ ones.

4. Digital manga virtual environment

Based on the work by Qu et al. (2008), we developed further their manga-me software [http://mangatech.tk] to automatically generate texture maps for the VE of a digital urban setting of any (UC-win/Road-) model. Richness preserving manga screening offers a solution to generating bi-tonal non-photorealistic screening for an input colour image. The goal is to preserve the visual richness in the original texture map of the model by utilising not only screen density, but also the variety of screen patterns. Our system consists of two major components, screening and line drawing, which are similar to the conventional manga production. For the line drawing part, we used a line importance model to rank each line. With this ranking, we can control the detail level of lines needed in the particular texture map for of the given UC-win/Road model, via a simple threshold. For the screening process, we utilise the technical solution of Qu et al. (2008) that automatically selects appropriate bi-tonal screens to represent (or fill up) different regions in the image.

Each type of screen supports a range of densities to represent different intensity. Therefore, whenever a screen is selected for a region, the intensity of this region can be approximated by matching the screen density. The major difficulty is to select an appropriate type of screen for each region, which can preserve the texture similarity and the colour distinguishability of the target regions in order to preserve the architectural content. However, to simplify the process we used only four to six different screens. This enabled us to archive results faster and have an overall more coherent texture maps that assemble the model of the VE. Akin to the generation of a 2D manga image as described at Schnabel and Qu (2011), our system starts by loading a texture map of a given model and segmenting the map into regions (Figure 4a). Then, the system provides the optimal assignment of screens for different regions (Figure 4b). This is done by first, projecting the available patterns from high-dimensional texture feature space to the low dimensional colour space, and then optimising texture similarity (Figure 4c). In addition, we are still able to control and/or override the selection of screens via simply tuning a few parameters. Finally, lines are detected and overlaid on the screens to finish the result and the original texture-map file is overwritten. The process has to be repeated for each texture map of the given model.
Figure 4. (a) An image with rich content will have thousands of segments. (b) Semi-automatic segmentation plus manual screen assignment. (c) Our automatic screen assignment significantly relieves user intervention producing reasonable results.

5. 3D digital manga implementation

We successfully converted ca. 2,500 texture maps of a sample model. Each texture map of the original model was mangarised individually without any context information of adjacent maps and then loaded back to the VE model. Some results can be seen below in Figure 5.

Figure 5. Screenshots of UC-win/Road VE: original (above) and manga version (below).

In September 2011, this novel ‘3D digital manga’ was showcased at the Tokyo Game Show (TGS) {http://tgs.cesa.or.jp} to test the acceptance and engagement with the general public. Two versions of the same model were presented on a large high-definition screen of ca. 3.5 m * 1.5 m. Using a mock-up car, users could ‘drive’ through an urban VE using either the mangarised or the original visualisation (Figure 6). An online movie-clip of the digital manga VE, titled ‘World16: Manga-Style VR Environments’ (2011), can be found at YouTube {http://youtu.be/gmN_HJGYfBU}. 
An interview with participants of a focus group stated that due to the interactivity, animation of the VE model and the augmentation of driving sounds they could experience a strong 3D immersion into the VE model. They affirmed that compared to the ‘normal’ version the 3D manga VE allowed them to understand better the design intent and fostered their spatial understanding of overall urban scenario. It was easier for participants to focus on certain aspects of the urban design and their experience by moving (driving) through the VE since the bi-tonal version allowed more engagement and had less visual noise. Participants confirmed that the quasi-realistic version of the original visualisation was often distracting due to its constant break of visual quality of texture-maps, perspectives, etc. and its inconsistency of lights and shadows. Despite some of these issues were also found in the manga visualisation, due to the overall look and feel of the model these errors became factors that enhanced the users’ experiences and allowed for a stronger emotional stimulation.

Since the VE software maps the individual textures onto 3D primitives to achieve their spatial visualisation, some of the mangarised maps did not match without any error onto the clear-cut original shapes and inconsistencies or errors arise. The biggest problem occurred due to the effect that the manga-me software is optimised to transfer images that contain context and diverse image components, information, multiple colours, textures, etc. Most of the texture maps of the VE-model however, were monotone, containing just one single texture, colour or hatching that referred to a specific spot of the 3D model. Subsequently the mangarisation of some maps were not as good as they would be in a 2D image that is full of context information. Some of these textures had to be adjusted and improved later. The software needs some further development to fit for all purposes of architectural visualisations in 2D or 3D. Despite this, the resulting visualisation of the mangarised models presents a distinct drawing style and allows for a unique experience and immersion of the digital manga VE.
Figure 7. Storytelling by including visitors into a mangarised urban scene.

Figure 8. Top: Digital Manga Sample at TKS
Bottom: Screenshots of UC-win/Road VE.

5. Conclusion
Our novel ‘3D digital manga’ allows designers develop a narrative that is akin to comic and cartoon reaching out for a wider audience for design communi-
The bi-tonal non-photorealistic depiction of VEs improves the users’ immersion, stimulation and engagement with the depicted architectural design in its urban setting and its visual simulation. Despite some limitations of the software, we demonstrated successfully how our manga visualisation for texture mapped 3D VEs allows designers to communicate both, visual richness as well as aspects of a narrative. Hereby architectural design communication is extended to a genre that is not only popular and commonly accepted, but also carries rich and meaningful content that merges sketching and digital drafting. Our technique allows for that architectural or urban design is communicated beyond the graphical depiction of architecture itself by elevating it from the backdrop to the protagonist of a mangarised narration.

Akin to Calderon et al. (2006) and Ng et al. (2006), we plan in our future research to address cinematic aspects of our architectural digital manga visualisations and generate animation techniques allowing designers to create architectural animations based on bi-tonal non-photorealistic depictions with the same ease as conventional animation methods. The challenges hereby are to adapt and consider solutions for the ‘depth of cinematic illusion’ and other relevant cinematic aspects that can be considered in a VE and to identify appropriate stages for such visualisations and design communications in architectural practices.

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