DIGITAL MANGA DEPICTION

MARC A. SCHNABEL¹ and YINGGE QU²
The Chinese University of Hong Kong, Hong Kong,
1. marcaurel@cuhk.edu.hk, 2. ygqu@cse.cuhk.edu.hk

Abstract. Same as rich colours in a painting that deliver the artist’s thoughts and ideas, the variety of textures and patterns in sketches gives drawings different significance. Using rich sets of texture screens to represent chromatic images, the visual perception can be preserved by using the texture pattern verities. In our work, we present a harmonic representation from chromatic space to textural space, to generate architectural sketches and their details, including colours, textures, and tones. We present a rendering appearance for the communication of architectural design akin to Japanese cartoon depictions. In our results we demonstrate successfully that our method generates sketches from architectural images that preserve architectural key-elements, such as surface or material properties and simulate a chromatic correct perception. This allows for novel depiction and story telling in architecture.

Keywords. Manga; sketching; story telling; non-photorealistic rendering; multidimensional scaling.

1. Introduction

Colour and texture are basic elements of what we perceive and comprehend in a drawing. The diversity of colours imposed on a painting expresses artist’s thoughts and ideas, which accordingly influence our visual experience and appreciation of the artwork. Similar to the function of chromaticity variance in colour paintings, monochrome sketches offer variations in textures and tones for the same purpose, subsequently the act of sketching allows for its own experience and interpretation of spatial arrangements (Goldschmidt, 1991). Digitally aided sketching either provides invariant patterns or requires user hand-drawn input for pattern variations. As seen in Figure 1(b), the computer generated diagonal hatching provides no distinguishability to the colourful content in the original image Figure 1(a).
In our work, we explore the harmonic depiction of chromatic and texture depictions that refer to creating a suitable interpretation of the internal relationship of colour plates using texture variations to provide a pleasant visual perception of both colours and textures of a computer altered drawing. We introduce novel depictions of images that provide an alternative rendering of a colour drawing/image into a harmonic explanation by using texture patterns (Figure 1(c)), and an extensional blending using both colours and textures (Figure 1(d)). This novel representation is especially useful in context of architectural depictions. Given an arbitrary colour image of an architectural arrangement, our computational method can instantaneously transfer the input into a bi-tonal multi-screening texture representation. Since architectural design is rich in details and elaborated in high levels, the process of creating an adequate illustrative sketch becomes even more complex. To speed up the production time of drawings, some artists already employ computer techniques to convert images to hatching effects, using techniques such as ‘half-toning’ or ‘hatching’. However, these digital methods produce only monotonous patterns and unsatisfactory results that are not in line with the rich expression of colour graphics and elaborated architectural details in sketches.

The graphical quality of our work is unique in its elegant use of rich set of screens, and tidy and fine drawing styles. This novel way of visual communication of both chromatic and textural features provides another realm for representing architectural drawings or photography, being real or virtual. Although sketched drawings depend on pure black and white (B/W) patterns and lines, or is bi-tonal representation, it is still possible to perceive the variety of textures or materials of the surfaces of buildings. During the screen-
process artists can lay multifarious screens to express different semantics. Here the ‘screening’ refers to the process of laying pre-printed b/w patterns over a certain area of the image. Screens are selected not solely according to the chromaticity, or tone, but also according to texture, material property, shading or even function of the underlying architecture that is being depicted and expressed.

Our technique can deal with an arbitrarily complex image or colour palette. Rich sets of texture patterns/screens are employed to represent the original image with the goal of preserving three key-factors of graphical representation: chromaticity distinguishability, texture similarity, and tone similarity. While the tone is preserved by matching the density of the tone with the one of each texture pattern, the core contributions of our method is the preservation of chromaticity distinguishability in a harmonic way; in other words to keep the perceptual distances between chromaticity by using variety of patterns. To this end, we develop a novel colour-to-pattern mapping based on the Multi-Dimensional Scaling (MDS) technique (Cox and Cox, 1994). As shown in Figure 1(c), our result preserves the original tone, while differentiate the chromaticity of the original image. Our system allows designers to interactively control and fine-tune their results.

2. Depictions

2.1. ARCHITECTURAL SKETCH

Architectural drawings are a universal convention that uses screens, symbols, hatches, line-types, -styles and -widths to describe elements of a design, its properties, functions or materials. They are filled with represented knowledge and key information for a specific composition. In addition to that, architectural drawings are flexible and allow the creativity of individual architects to influence the overall style of the screens and their variations. 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.

Since the 16th century the tradition of drawing as an act of designing freed the architect from working on site and subsequently design became also an intellectual discipline engaged in the plane of paper. Goldschmidt (1991) argued 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 the architectural sketch remains the predomi-
nant 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 architectural 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) (Figure 2).

The architectural sketch that is similar to an artistic drawing uses various graphical elements and drawing techniques to express visual clues of the depicted scene. Texture materials can be rough, bumpy, slick, scratchy, smooth, silky, soft, and others, while having various patterns. Painters and sculptors who work in the realism style imitate natural surfaces and textures. The artist paint textures to create an illusion. In the same way, the architect can use the texture
to difference a place to other, and create in them different sensations. Subsequently our computational representation is able to re-represent these fine nuances of hand sketching that differ greatly from computer generated renderings or ISO (2002) conventions (Figure 2).

2.2. ARCHITECTURAL MANGA

Manga, a popular Japanese comic art form, is increasingly becoming known around the world. Manga are used to develop a storyline that engages the reader not only with the visual aspects, but also other sensorial feelings. The graphical quality is unique in its elegant use of rich set of screens, textures, tidy and fine drawing styles. This specific way of visual communication provides a novel realm for representing architectural drawings or photography, being generated real or virtual (Figure 2). Architecture is subsequently not only represented through its factual dimensions of length, width and height, but is extended to intangible sensorial realms.

Our specific method allows architects a novel way of storytelling and depiction of their designs, from a wide overview to rich details. Plan, section and elevation are fundamental parts of architectural communication. Many methods have been explored to express architectural designs in other ways of depictions. Japanese comics in particular use strong expressions and rich set of drawing details to engage with the readers with their stories. Hereby the protagonist acts in front specific architectural settings. Our method elevates the background—the architectural settings—to the protagonist and to the foreground. Subsequently the storyline centres around the architectural design.

3. Overview of the Harmonic Textural Drawing System

Richness preserving manga screening offers a solution to generating bi-tonal manga screening for an input colour image (Qu et al, 2008). Their goal is to preserve the visual richness in the original photograph by utilizing not only screen density, but also the variety of screen patterns, during manga drawing. Base on this work, we develop a system to draw architectural depictions using variant textures and level of abstracted lines. Our system consists of two major components, screening (texture rendering) and line drawing. For the screening process, we use mathematic schemes, the MDS (Qu et al, 2008), to map between the colour space and the texture space, by preserving the relative distance among each individual space meanwhile. In this way, we build the harmonic relations for texture variances, in terms of the corresponding colour perceptual difference. Our aim is to provide a mapping scheme for the texture rendering with the goal of chromaticity-difference preservation, so
that the textural rendering has a harmonic appearance with the original colour image, in visual perception context. For the line drawing part, we propose a line importance model to rank each line. With this ranking, architects can control the detail level of lines needed in their architectural drawing, via a simple threshold.

3.1 HARMONIC TEXTURAL DRAWING

The main objective of screen matching is to preserve the rich content of the original reference image. Here, we aim to preserve three classes of contents including tone (or luminance), texture and chromaticity distinguish-ability. Therefore, the screening method consists of the following three steps:

- **Texture-based matching.** As illustrated in Figure 3(a), segments containing apparent texture are first matched with screen patterns based on the texture similarity. This guarantees the pattern features on the architecture will be remained in the B/W manga drawings. To do so, we choose the Gabor wavelets texture feature to capture the representative feature in each regions of the input photo. Next we compare the feature vectors between the input photo and the features of each screen in the screen library. The most closest one from the screen library is then chosen to render the target region area. Figure 3(a) shows an example matching of the textured wall with the screen “bricks”.

- **Colour-to-pattern mapping.** The unmatched regions are mapped to different pattern types with the goal of maintaining colour distinguishability, via a colour-to-pattern mapping. We use MDS to map between the colour space and the texture space, by preserving the relative distance among each individual space meanwhile. In Figure 3(b) we assign the bottom patterns to the above colours. Subsequently, we assign red and orange regions with two close patterns, as they are closer in colour. While blue regions will be screened with a substantially different pattern. In other words, we maintain the relative distance among colours after mapping to the screen space.

- **Tone matching.** After the first two stages, each region has been assigned a screen type. The final step is to perform a tone matching by selecting the appropriate screen density. We match the overall greyness of the screen with the average luminance of the segment (Figure 3(c)).
3.2. LINE DRAWING AND ABSTRACTION

Edge detection extracts lines purely based on the intensity gradient in the image. No attention is paid to the importance of a line. In many cases, edges obtained by automatic edge detection methods are far from satisfactory as demonstrated in Figure 4(b). However, lines drawn by artists are usually tidy without being too crowded or chaotic. Some artists intentionally omit many detail lines in order to maintain the tidiness and abstraction of the drawing. However, structural lines are retained, meaning that some lines are more important than others, and these lines usually form the main structure of a building or spatial arrangement. Therefore, we propose a model to measure the importance of a line and unimportant lines are filtered out by adjusting a single threshold.

We begin our line formation from the edge detection on the original image. We adopt an improved edge detection method (Meer and Georgescu, 2001) that shows the ability to detect consistent results, even on weak edges.

To tell structural lines from details, the key is to determine the importance of a line, so that a high importance value indicates structural lines while lower value indicates detail lines. Architects usually first draw the long and straight structural lines during sketching. The short and curly lines are drawn at later
stages or even omitted (Cheng, 2006). Hence, the curliness and the length of lines suggest its importance. We also believe that lines associated with the major segment in the photograph should be more important. This suggests four factors are to be considered, the length, the curliness of a line, the size of largest associated segment, and the visibility value. Figure 4(b) shows the unstructured edges from the raw edge detection result. With the proposed line importance model, we can generate the lines with a desired degree of abstraction to simulate architectural drawings with different level of complexity or line abstraction. Figure 5 shows five different levels of abstraction of lines.

Figure 5. Level of line abstraction controlled by the line importance values.

4. Results and discussion

A variety of input examples, including architectural photographs, colour drawings and artworks of spatial descriptions have been testified with our automatic drawing system called ‘Mange-Me’ {www.manga-me.tk}.

In Figure 6 we show an example that demonstrates the chromaticity distinguishability of the proposed system. Unlike the monotonous pattern appeared in the halftone result in Figure 6(b), the colour variety in the input photo is well preserved by with screen variety as shown in 6(d). We used five screens to represent five distinctive input colours (Figure 6(c)). By blending our result with the input image, such result illustrates the faithfulness of our textural presentation and emphasizes the relationship of building elements with each other as well as to the whole architectural design.

This is particular useful to communicate large concepts that feature a variety architectural topologies, material, form, details as well as additional abstract information, such as design intent, light qualities, movement, and depth. Subsequently texture rendering can enhance the communication of architectural representations. Our technique allows designers to abstract spatial relationships while at the same time preserve properties of material, surface or detail.

Our technique allows for the development of a unique architectural design communication that goes beyond graphical depiction of technical drawings moving to story-telling using the particular style of comics. Figure 1(d) dem-
onstrates a novel drawing style by blending the texture rendering with the colour rendering. It lifts the drawing in both semantics.

![Images of diagrams](image)

**Figure 6.** Unlike the monotonous pattern in halftone technique (b), the colour variety in a colour input photo or drawing will be well preserved with screens variety, as shown in (c), by our colour-to-pattern mapping (d).

Despite Stacey and Eckert’s (2003) findings, it is commonly understood that sketches express an added value to the communication. The strengths of architectural sketches often lay in the ambiguity and abstract translations of the original depicted or imagined spaces and designs. Our technique allows architects to blend from a photorealistic to an abstract depiction of architecture using a distinct expression of akin to the Japanese tradition of manga.

### 5. Conclusions

We have presented a novel drawing technique for harmonic texture drawing with colour drawing that utilize texture drawing techniques, and provide an optimal screening scheme by using multiple screens and level-of-detail line abstractions. The high dimensional screens enable the texture and tone preservation, as well as the harmonic chromaticity representation of the depicted original (Figure 7). The system is efficient and convenient in use in architectural design and communication. We demonstrated how the specific textural drawing technique can be utilized to design and communicate spatial arrangements. The intersections of manual and digital instruments mirror the working styles of architects, who deal with a variety of realms, instruments and stakeholders. Hereby this harmonic texture and colour drawing aids not only users to understand larger architectural concepts, properties of form, material, light, etc, but also story telling, developing a narrative (Ng et al, 2006), and e.g.
consultancy of professionals (Schnabel and Howe, 2009). Laypersons easily can access the architects’ intention of design and function.

![Figure 7. Our mange-style depictions properly preserve the multiple textures and colour-distinguishability of the original urban scenes.](image)

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**References**


