Abstract. Chinese calligraphy can often represent both sensory and formal expression of design concepts through its characteristics within the hand kinesis and motions expressing a writer's direct intentions. We propose an architectural form exploration interface for simulating Chinese calligraphy concept to give a rich dimensional mapping with architectural form for designers who might not be skilled in Chinese calligraphy.

1. Introduction

Chinese calligraphy as its soft-line medium the hairy brush, can often represent both the sensory as well as formal expression of design concepts. Therefore, if Chinese calligraphy can be applied as a design media for conceptual inspiration such as form exploration, we might be able to unleash the sensory design knowledge for further understanding.

In respect of traditional Chinese calligraphic skills, designers might not have the skills but could have the concept to illustrate calligraphy with intuitive hand kinesis and motions. Several research issues addressed are: (i) the richness of Chinese calligraphy itself as a design media contrasting to sketch media in spatial form exploration and (ii) the mapping issues of Chinese calligraphic sketch device with design elements. In this research, we propose a spatial form exploration mechanism using the Chinese calligraphy. Further, a testifying device is implemented through a hand motion simulated Chinese calligraphic brush device.

2. Relevant Researches

For finding an intuitive physical device for the purpose of this research, several implementations with data gloves and other immersive environments are reviewed. Schkolne et al. (2001) presented Surface Drawing system for creating organic 3D shapes in a manner which supports the needs and interests of artists. The medium
facilitates the early stages of creative design which many 3D modelling programs neglect. (Wong and Ip, 2000) presented Virtual Brush, a model-based approach to synthesizing realistically Chinese calligraphic writings.

What Calle and Kaovas (1992) presented is an intuitive architectural sketch design, the aim being to provide computerized tools for stimulating and supporting an architect in the early creative phases of sketch design under the headings of ‘complexity of design’ and ‘design knowledge’. With these reviews in mind, we will discuss our sketch media—Chinese calligraphy—like hand movement form sketch system (CalliHand).

3. Using Chinese calligraphy as sketch media

Conventionally designers explore form concepts by using hard-line media such as pens or pencils for their quick and effective expression. The feedback process is personal and recursive until a satisfied result comes up by seeing and moving sketched objects (Do et al., 2000). On the other hand, calligraphy, literally the art of beautiful writing, has not only lifted writing to levels of technical perfection, but used words and word rhythms to create images which transcend craft and has elevated it to a noble art form. Thus, as all art forms, calligraphy gives us new perceptions of ourselves and our very being (Harris, 1991).

Figure 1 shows the contrast between conventional sketching and using Chinese calligraphy brush as sketching media. In earlier creative phases of design sketching, hard-lined tools such as pens or pencils are used to draw overlapping lines for declaring ambiguous edges instead of more concrete edges, and coming-and-going lines on adjacent edges to represent shades. These two features can be replaced with the concept and characteristics of writing Chinese calligraphy as the sweeping brush soft-lined tool.

Figure 1: Design sketching media differences.

Writing with traditional Chinese calligraphy presents rich textural and unstable
linear trajectory of brush strokes. Consequently, Chinese calligraphy provides both writing and drawing concepts at the same time. This presents more concentration on the emotional intentions within the writer’s activity and media used than either the symbolic context of the written words or well declared edges.

On the other hand, the cursive structures and strokes of characters have the composition and limitation rules over the interaction in writing activity. Contrasting to the rules that perform as design knowledge and constraints, such knowledge determines how this sketch media can be different from totally free drawing. Therefore, the writer shall express the tension in the writing under and over the rules.

### 4. Sketching Forms with Chinese Calligraphy

The writing mechanism of Chinese calligraphy is on the skill and perception of stroke-based illustrating by hand kinesis strengths and motions, which are well-formed and therefore can be expressed in terms of computation as strength values and coordination of traces. However, the heart of calligraphy is still the interactive process whether sketching or writing. Hence, by mapping the characteristics of Chinese calligraphy to basic form making capabilities, we gain several mechanisms for embedding Chinese calligraphy into form exploration process in terms of visual expression.

With such purpose, the visual expression of Chinese calligraphy identified by Chang (1992) are its writing skills, brush strokes, and inkiness. Furthermore, three basic Chinese hairy brush skills (Chou, 1995) are:

1. Handling: holding, motion, weight and energy, inkiness.
2. Character structuring: scaling and skewing, stroke density and stress, structural conflicting.

Thus, mapping between Chinese calligraphy skills and spatial composition can be identified as shown in Table 1.

Designers who are not familiar with these skills can be enhanced by an intuitive interface through a digital device such as data glove. This gives power to the user to conceptually illustrate Chinese calligraphy by hand gesture and motion. Practically, Chinese Cao-style calligraphic stroke can be identified by nine types shown in Table 2, which define the start and the end of a stroke trace for recognizing hand motions.

We use the Cao-style of Chinese calligraphy not only because its brush strokes highlight various effects of brush strokes, but also because it is the most unrestricted style compared to others to express visual and emotional intentions of writers through purely illustrating the linear and curvature strokes.
TABLE 1: Mapping between Chinese calligraphy and spatial composition.

<table>
<thead>
<tr>
<th>Handling</th>
<th>Chinese Calligraphy Skills</th>
<th>Spatial Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Brush holding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Motion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1) Velocity</td>
<td>Time, kinesis</td>
</tr>
<tr>
<td></td>
<td>(2) Energy</td>
<td>Free line, contrast</td>
</tr>
<tr>
<td></td>
<td>(3) Curving</td>
<td>Direction, continuity</td>
</tr>
<tr>
<td></td>
<td>(4) Starting/Ending</td>
<td>Edge quality</td>
</tr>
<tr>
<td></td>
<td>(5) Tangency</td>
<td>Taste</td>
</tr>
<tr>
<td></td>
<td>3. Weight and Energy</td>
<td>Rhythm, expense</td>
</tr>
<tr>
<td></td>
<td>4. Inkiness</td>
<td>Surface</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brightness, shining</td>
</tr>
<tr>
<td>Character Structuring</td>
<td>1. Scaling and skewing</td>
<td>Boundary, edge</td>
</tr>
<tr>
<td></td>
<td>2. Stroke density and stress</td>
<td>Partitions, branching</td>
</tr>
<tr>
<td></td>
<td>3. Conflicting</td>
<td>Limitation, dimensions</td>
</tr>
<tr>
<td>Chapter Composition</td>
<td>1. Position</td>
<td>Peripheral relation</td>
</tr>
<tr>
<td></td>
<td>2. Partitioning</td>
<td>Balance, contrast</td>
</tr>
<tr>
<td></td>
<td>3. Coherency</td>
<td>Direction, expense</td>
</tr>
</tbody>
</table>

TABLE 2: Cao-style calligraphy strokes and their traces.

5. The intuitive device: CalliHand

CalliHand is a Chinese calligraphy-like hand movement form sketch device. The system components of CalliHand are shown in Figure 2.

The requirement of a multidimensional (position, rotation, pressure and fingers bending) input device, is captured by the hand motion device. The information is further analyzed by the API of device we choose. The system is developed using C++ for accessing the data glove through the data glove API, and using Simple Direct media Library (SDL) for GUI interaction programming and TGA image exportation.
With CalliHand, users can construct geometry models for representing conceptualized Chinese calligraphy writing skills which can be divided into representations (Strassmann, 1986) declared as brush, stroke, dip and paper.

The exploration starts with a defined base ground. While the user “sketch as” freely using hand motion device, chunking by the palm closing, the system analyzes and records trace data from the device. With the stroke interpreter, system dynamically visualizes Chinese calligraphy strokes generated by user’s trace coordination information and strength data. For each hand movement, the system will trace what the user has made. Three methods are provided to explore possible forms as a source of inspiration, namely:

5.1 CIRCUMSCRIBE POLYGONAL STRUCTURE OF CHARACTERS

As shown in Figure 2, we integrate a character structure exploration for Chinese Cao-style calligraphy of connecting outmost ends of strokes as a circumscribe polygon. The system then produces surfaces with strokes in space. This frames a mechanism for interactive exploration architectural forms in structuralized view of calligraphy character structure.
5.2 STROKES AS RESTRICTING BOUNDARIES

Strokes created by user become surfaces which are connected with round faces. Each of the strokes can be assigned for a boundary and be identified to inner or outer boundary with the normal vector of the round faces. Hence, the system allows user to place a solid and the solid is partitioned by stroke surfaces, and become design forms. (Figure 3).

![Figure 3](image)

Figure 3: Architectural form generated from method 5.2.

5.3 Refined Stroke Traces

For each stroke the user makes which has strength and position data, it may still be partially unmindful and have uncertain identity to Chinese calligraphy characteristics. The system thus simply recognizes the stroke traces by comparing with four-segment paths with a library of Cao-style calligraphy templates, and applying refined strokes as surfaces to original stroke traces. This becomes a space illustration of Chinese calligraphy upon an architectural form within for exploration (Figure 4).

![Figure 4](image)

Figure 4: Architectural form generated from method 5.3.

The created stroke and trace data can be stored with edit points and strengths for iterative modifications. Views can also be output as still images for inspiration or other purpose.
6. Conclusion

Design sketching with Chinese calligraphy as its unique characteristics can provide outstanding thinking in sketching of hard-line drawing tools. The notable features with Chinese calligraphy are: (i) varied inkiness, weight and softness through one stroke provides ambiguous, rich textural and unstable linear trajectory of brush strokes, and (ii) shaping structures of strokes support character structural point of perception to form exploration.

In our work, Chinese calligraphy illustration as design interaction in spatial form exploration to provide the exceptional interactivity and exploration behaviours are with: (i) 3D strokes and their edit points as meanings of design sketch, (ii) transformation from 3D strokes to spatial forms such as frames, surfaces through various perceptions, (iii) viewing in the space of writing, and (iv) motion of writing behaviour as spatial form visual expression.

References

Chou, Z. C. 1995, Calligraphy Art and Appreciation, Ia-Tai Publish, Taipei, Taiwan.