MEASURING THE PERCEPTIVE INTRICACY OF THE CHINESE SCHOLAR GARDEN

HAOFENG WANG\(^1\) and CHRISTIANE M. HERR\(^2\)

\(^1\)Shenzhen Key Laboratory for Optimizing Design of Built Environment, Shenzhen University, China
\(^1\)whf@szu.edu.cn
\(^2\)Xi’an Jiaotong-Liverpool University, China
\(^2\)Christiane.Herr@xjtlu.edu.cn

Abstract. The carefully orchestrated relationship between view and movement forms a core composition principle of Chinese scholar gardens to create poetic depth. We focus on one characteristic case study to examine the intricate spatial relationships between what is visible and what is accessible from the garden visitor’s perspective. We examine the garden layout through a quantitative approach based on Visibility Graph Analysis. We identify a certain congruence between visibility and accessibility patterns, and propose that a network of strategically distributed overview spaces is employed throughout the garden to counterbalance tensions generated from disjunction between visibility and accessibility. The paper offers new insights into how quantifiable aspects of the garden can be used to generate qualitative perceptions of elegant restraint and compositional intricacy.

Keywords. Chinese scholar garden; Landscape design; VGA analysis; Overview space; Purview interface.

1. Introduction

The experience of visiting a Chinese scholar garden has often been compared to a “stroll in a painting”, which implies the simultaneous experiencing of visual and kinesthetic aspects of the garden. The relationship between view and movement is carefully orchestrated and forms a core composition principle consciously employed in the design of Chinese scholar gardens to create poetic depth (Li and Yeo 1991). Visitors to these gardens experience a disjunction between visibility and accessibility: multiple pathways and bridges, walls, openings, trees, winding waterways and rockeries create intricate layouts in which the directly visible is often not directly accessible (figure 1). The creative composition and disjunction of visibility and accessibility can be understood as a spatiotemporal art form that generates a rich variety of events and sensations involving encounter, discovery,
expectation and recollection, temporary disorientation and a return to the known while strolling in the garden (Bedingfeld 1997; Chen 1984; Lu 2010; Lu 2011). Chinese scholar garden design has previously been analysed and discussed primarily in analogy to pictorial art, and few attempts have been made to identify a coherent rationale in its compositional approaches. However, many sources also comment on a certain holism or unity that connects intricate spatial arrangements in the Chinese scholar garden, along with a general preference for the implicit, removed and ambiguous over the explicit and clear (Chen 1984; Peng 1986). In this paper, we attempt to capture and describe this holistic quality in the Chinese scholar garden by examining the relationship of spaces that are visually and physically accessible with a quantitative approach based on Visibility Graph Analysis (VGA).

As a characteristic case study, we examine the Master of the Nets garden, a famous Chinese scholar garden located in Suzhou, China (Liu 1979). The garden has been documented to exist for almost nine centuries but has been rebuilt several times until the late Qing Dynasty (ca 1868). The garden covers an area about 0.5 hectares, and consists of two parts: the residential part and the garden, which constitutes four fifths of the compound (figure 2).

From a perceptual point of view, the garden is full of changes. The open-floor spatial organisation of buildings, numerous openings on walls, and constant interplay between that which can be seen and that which can be accessed form what has been described as scenes beyond scenes, and gardens within the garden, creating the effect of boundlessness while achieving a unity of part and whole. The garden is appreciated for its masterful handling of relative dimension, contrast, foil, sequence and depth, and borrowed scenery, which demonstrates the characteristic quality of Chinese garden design of synthesising art, nature and architecture (Chen 1984).
2. Methodology: Visibility Graph Analysis

The study employs Visibility Graph Analysis (VGA) of Space Syntax (Hillier 1996) analysis to investigate the spatial relationships between visibility and accessibility embedded in the garden layout. VGA was developed based on the concept of isovists as introduced by Benedikt (1979). An isovist or visibility polygon is the area visible or accessible from a given vantage point, in which all other points are directly visible from that point (figure 3). Benedikt argued that the geometric properties of visibility polygons could give insights into human perception and navigation of spaces as they capture the variation of visual fields experienced during movement (Gibson 1978).

Turner et al (2001) extended the measurement of properties of singular isovists into the configurational analysis of Space Syntax by describing the relationship of a position to all others in the analysed space according to the topological distance required to reach them. They developed a computer program called Depthmap to perform visibility graph analysis of plan layout, which models a plan layout into a grid system of point locations and represents the degree of relative connectivity of all the mutually visible locations across that system. Various measures and parameters taken from a combination of space syntax techniques and geometrical properties of isovists are then used to quantify both the local and global properties of point locations within an overall grid system. Some recent studies have focused on extending VGA analysis to overcome limitations of Depthmap resulting from not adequately capturing “inaccessible but visible” spaces, such as experimental studies in 2D layout (Taniguchi et al. 2012) and 3D environment (Varoudis and Penn 2015).
Previous empirical studies have established that the visibility patterns of building layout influence different kinds of cognitive processes and behaviours (Peponis et al. 1990; Choi 1999; Yin et al. 2016). Extending these studies, Yu et al. (2016) applied VGA to analyse the perceptual properties of traditional Chinese scholar gardens, and suggested that the spatial transparency and ambiguity of the Chinese garden can be related to local visual isovists properties and global path structure.

3. VGA Graph Measures

As the scope of this paper is limited, we refer readers interested in key VGA notions to the previous works outlined in the previous sections, and concentrate here on analysis of the plan layout of the Master of the Nets garden through the Depthmap software. In order to capture the spatial effects arising from the disjunction between view and access, the garden layout is analysed through two separate spatial systems: the eye-level visibility map where only obstacles to direct views are treated as boundaries; and the knee-level accessibility map where anything blocking physical movement is treated as a boundary. In both cases, trees and furniture are omitted for preliminary simplification. While this may not address the garden in its multi-dimensional totality, it is well established that in contrast to Western gardens, Chinese gardens rely primarily on the placement of architectural elements for their compositional aims, with plants playing only a minor role (Bedingfeld 1997; Yang 1994). We apply a grid of 0.6x0.6m tiles to construct the VGA map of the case study, approximating human scale and step length. Only occupiable spaces bounded by the accessibility map are populated with grid tiles: accessibility and visibility map have exactly the same number of tiles; the difference is that their graph measures are computed using different boundaries to generate visibility polygons.

In the following sections, we compare the VGA graph measures of the visibility map and accessibility map as derived from the garden layout. The differences between the two systems are investigated to highlight the disjunction between the visible and the accessible that creates the spatial effects experienced in the Chinese scholar garden.
4. Measuring the Separation of View and Access

We first examine the degree of separation between visual and physical accessibility as seen from individual viewpoints, assuming that the geometrical properties of the visibility polygon can give insights into human perception of space. Figure 4 illustrates value differences between visibility and accessibility maps, visualising differences in a consistent colour spectrum of red to blue (showing values from high to low).

Figure 4. Comparison of direct purview (top row) and mean turns (bottom row) between visibility (right column) and accessibility (left column).
The spatial disjunction of view and access can be immediately observed in the
direct purview analysis when comparing the visibility map with the accessibility
map. The two maps display distinctive spatial patterns in terms of value distribu-
tion. In the accessibility map, direct purview appears to be strongly differentiated
between high and low values. Spaces with strong direct purview are distributed in
a more dispersed pattern, focusing on individual courtyard buildings and reaching
a peak in the main reception hall of the residential quarter. On the other hand, val-
dues of direct purview in the visibility map have a relatively weak differentiation.
When focusing on direct purview, a more centralised pattern emerges, which is
dominated by spaces around the central pond and has little overlap with spaces
that have strong direct purview in the accessibility map (figure 4).

The differences of global purview measured in mean turns between the two
systems are also remarkable. The value of mean turns in the visibility map is only
about one third of the value found in the accessibility map (1.91 vs. 5.41), which
means the visibility map is much shallower and hence simpler than the accessibility
map. In the accessibility map, lower mean turn values associated with spaces of
strong global purview form a rather compact, inward-looking shape around the
central quarters of the eastern part of the garden. In contrast, the visibility map
features lower mean turn values radiating from the central pond and spread evenly
through most parts of the garden except of the eastern residential house. Like the
direct purview maps, the visibility and accessibility maps have little overlapping in
terms of distribution of spaces with strong global purview. This clearly illustrates
that the separation between visibility and accessibility systematically creates the
spatially complex or even paradoxical situations experienced in the garden: that
which you can see through but not walk through; while everything appears to be
close it remains difficult to reach physically.

5. Symmetry and Circularity

We argue the association of syntactic property (measured in number of turns) with
the metric property (measured in meters) in the accessibility system of garden is
an important means to create the spatial effects and intricacy mentioned above.
The twisting character of the access system of the garden can be shown with a
simplified representation of the routes as a line system. As shown in figure 5,
the route system has almost no dead-end path. Intersections of circulation are
predominantly 3-way T-junctions, and cross intersections are very rare. There are
many loops in the circulation system, but they are small in size and topologically
deep in the sense of more than expected direction turns contained in each ring.
Intuitively, the circulation system appears to be fragmented into many smaller and
mutually interlocked loops. Walking further in the garden always means walking
in circles, with constant route bifurcations diffusing path direction.

What can be inferred from this analysis is that the topological structure of the
garden’s circulation system is both circular and symmetrical when seen from any
location within the garden. Here we find a different spatial logic from that of build-
ings and urban spaces examined elsewhere in space syntax literature, namely, the
using of linear connection of space to reduce topological distance at the expense
of increase of metric distance (Peponis 2012; Hillier 2003). The garden layout
minimises spatial differentiation in terms of linearity of space organisation, thus reducing the syntactic (topological) properties to the metric. The dominance of circularity, diffusion and symmetry in the circulation structure seems to generate perceptions of uncertainty, endlessness and maybe even disorientation. If the visibility system of the garden creates strong visual connections, then the circulation system seems to create the effect of corporal avoidance, where social co-presence or encounter happens more likely by chance rather deliberately.

Figure 5. Step depth analyses of the main entrance and a centre location showing the evenly distributed depth gain as a result of symmetrical and circular route system of the garden.

6. Spatial System

To examine more closely the relationship between spaces with strongest direct purview and spaces with limited purview in the accessibility map, we apply the concept of purview interface introduced by Peponis (2012). Spaces with the strongest direct purview (top 10% of all tiles) are defined as overview spaces. We analyse how far in number of direction turns or in metric distance other spaces are from these overview spaces.

About 80% of spaces in the garden are two or less turns away from the nearest overview space, and 35% of them are directly accessible (0 turn) from an overview space. The average number of turns to the nearest over-view space is 1.3, which is less than one fourth of the mean turns of all tiles. Moreover, the metric distance of 83% of all other spaces from the nearest overview space is no more than half of the mean distance of those spaces from all spaces. The average mean metric distance of all other spaces to the nearest overview space is 12.3m, which is less than one fourth of their mean metric distance from all spaces.
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The average visual turns from other tiles to the nearest overview space is 0.37, of which nearly two thirds (65%) of other tiles are directly viewable from an overview tile, and one third are viewable by one eyesight turn. Based on these results, the garden layout can be understood more easily due to the proximity of spaces with limited direct purview to overview spaces that offer more extensive direct purview. Overview spaces function as a reference allowing a localised simplification of the complex spatial relations of the garden not only because they afford more direct connections but also because they are more powerful in synchronising relationships by access or by view. The overview spaces are well distributed, forming into local clusters with varied size and shape, and associated with different domestic functions. They are separated from each other and not inter-visible or inter-accessible directly from each other (more than 4 turns by walk and more than 1 turns by view). Unlike the findings of building analysis conducted by Peponis (2012), the garden does not seem to form a continuous purview interface or a cognitive skeleton (Kuipers et al. 2003) by linking the overview spaces into a network. Rather, the overview spaces of the garden function as discrete cognitive references. They are partially exposed to views and physically removed from each other. Their strategic distribution creates distance between them, both in terms of view and access. The spatial experience of the garden is synchronic and diachronic simultaneously: It is synchronic in the sense that the strategic distribution of the overview spaces brings with it the synchronisation of many relationships both in terms of view and access. It is diachronic in the sense that the cognitive reference offered by overview spaces fragments into local clusters hidden from each other, which shades the continuity of purview interface and makes trajectory perception of garden as a spatiotemporal event. In future, we are planning to follow up questions arising from our observations, such as whether the properties identified in our study can be intentionally planned, or under which circumstances they can arise.

7. Conclusions

While this paper focuses only on a limited aspect of the garden captured with VGA analysis, results offer a differentiated view on how it is possible to create simultaneously perceptions of ambiguity and subtle overall compositional order. According to our analysis results, a key aspect of the spatial organisation of the Master of the Nets garden seems to lie in the way eye-level visibility and knee-level accessibility are disjointed, creating a sensation of elegant restraint and allowing for various unexpected encounters. This perception of ambiguity and slight disorientation is counter-balanced by strategically distributed depth-compressing overview spaces. These spaces allow localised simplification and orientation within the intricate overall spatial networks. In general, organisation of the garden space as it appears based on the VGA analysis presented in this paper can be characterised as non-linear, often circular and networked in the form of interconnected smaller loops, embracing diachronicity and temporary order within larger ambiguous contexts. This characterisation resounds not only with previous descriptions of the experience of moving through a Chinese scholar garden, but also with composi-
tional principles typically found in classic Chinese landscape painting. As this type of space is difficult to describe in linear and deterministic terms, the type of analysis presented here may offer opportunities for qualitative design applications of a highly quantitative form of analysis.

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