VISITING, PICTURING AND EXPERIENCING THE CHINESE GARDEN

Thesis for the Degree of Master of Fine Arts in Information Design and Visualization

Northeastern University
Visiting, Picturing and Experiencing the Chinese Garden

Thesis Presented by
Muhe Yang

To The College of Arts, Media and Design
In Partial Fulfillment of the Requirements for the Degree of
Master of Fine Arts in Information Design and Visualization

Advisor: Kristian Kloeckl
Readers: Shuishan Yu and Xiaofeng Fang
Thesis Committee: Ann McDonald, Pedro Cruz, and Dietmar Offenhuber

Northeastern University
Boston, Massachusetts
April, 2017
Acknowledgments

This thesis marks a milestone of my two-years' study in Information Design and Visualization program at Northeastern University. I would like to thank all the people who contribute in some way to the work described in this thesis.

I would first like to thank my thesis advisor Professor Kristian Kloeckl, who gave fully respect to my ideas and consistently allowed this thesis to be my own work. I really appreciate those helpful advices and suggestions he gave me. I would like to thank faculties in IDV program, including Professor Pedro Cruz, Professor Nathan Felde, Professor Dietmar Offenhuber and Paul Kahn, who generously offered me plenty of valuable advices throughout the whole thesis process. I would also like to acknowledge Professor Shuishan Yu of the School of Architecture at Northeastern University, who gave me helpful suggestions and discussion about my thesis. I would also like to acknowledge another expert in Chinese garden, Professor Xiaofeng Fang at Tsinghua University, whose suggestions inspired me a lot. And I am gratefully indebted to Professor Yu and Professor Fang for being readers of this thesis and their valuable comments on this work. Besides, this thesis would not be complete without suggestions, discussions and helps from my fellow classmates in IDV program.

Last but not least, I would like to express my profound gratitude to my parents for providing me with unfailing support as always.
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ABSTRACT OF THESIS

Submitted in partial fulfillment of the requirements
for the degree of Master of Fine Arts in Information Design and Visualization
in the Graduate School of the College of Arts, Media and Design of
Northeastern University
April, 2017
Chinese gardens are regarded as the result of interaction between nature and culture, and play an irreplaceable role in understanding design principals and traditional Chinese culture for professionals and laymen alike. Although the significance of Chinese garden has been universally recognized, there is few information visualizations specifically focused on this topic. Therefore, with the objective of helping audiences to have a better understanding about Chinese gardens, this thesis looks into how people experience the garden from two perspectives. Taking the Humble Administrator’s Garden as an example, this work first investigates how people visit the garden by simulating the circulation from bird’s-eye view, before focusing on people’s visual experience in the garden from perspective view and revealing seasonal change of colors in the garden through photo analysis. The visualizations created in this thesis reflect people’s experience about the garden as well as some unique characteristics of both the garden and the culture behind it.
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Chinese Garden

Photo credit: Zhang Chaoxian
Once in a while, getting tired of ordinary daily life or being stuck in tedious works, as city dwellers, we cannot resist an idea of escaping away from this tiresome city life and coming back to nature. We want to live in a place where we can enjoy the serenity and pastoral scenes as in countryside while not being too secluded to lose the convenience of living in the city – an imagination that seems too wild to be true. However, Chinese classical gardens, also known as “mountain and forest in city”, are just places of this sort. Commonly located in cities, Chinese gardens integrate the best aspects of both countryside and city, offering people a chance to experience the beauty of nature and poetic dwelling.

As every place is a representation of the process of interacting between local nature and culture, there is no doubt that every place is filled with information reflecting its own identity in certain ways. As a place evolving through time, both indigenous people and products exert key impacts on the developing process, including local craftsmen utilizing traditional skills and local materials used in construction. Chinese classical gardens, especially, are embodiments of relationships between nature and culture and also are places rich of various kinds of information – could it be spatial or temporal, functional or aesthetic, in that “Chinese gardens are cosmic diagrams, revealing a profound and ancient view of the world, and of man’s place in it” (Keswick, 2003). Consisting of a wide variety of visual elements, including architecture, water areas, plants and rock mountains, Chinese garden design is about dealing with arrangement and appearance of various elements in a natural way. Ji Cheng suggested in The Craft of Gardens (Yuanye), the most influential and specialized monograph on Chinese garden design, that: “it should seem too natural to be made by humans”, accentuating the significant role of nature in methods and goals of Chinese garden (Ji, 1988).
When walking through winding paths in Chinese gardens, visitors are surrounded by constantly changing and delicate combinations of various elements during different time of year, and it is natural that everyone has his or her own ways of visiting and perceiving gardens thus has different experience about the garden from others. Whether the focus is on burgeoning willows in spring, or pink lotus blossom in ponds, or yellow leaves fallen on a rock mountain, or a pavilion standing in a snowing day, they are all parts of people’s visual experience in the garden.

Although the importance of Chinese gardens has already been recognized among professionals and laymen alike, there is hardly any information visualization specifically focused on this topic. Therefore, taking the Humble Administrator’s Garden as an example, this thesis explores how people experience the garden: first looks into how people visit the garden, and then further focuses on how people visually experience the garden, with different methods and perspectives being applied in two experiments. With the idea of making gardens more decodable, the goal of this thesis is to create visualizations that can reflect visitors’ experience in a Chinese classical garden, especially visual experience. On the one hand, for those who do not know much about them, I hope that the visualizations could invoke their interests in Chinese gardens. And for those who have been there before, the works could also be able to remind them of their memory and experience in Chinese gardens. Through this project, I hope that audiences could have a better understanding about Chinese gardens – an epitome of Chinese culture.

The rest of the thesis is comprised of five parts. The first part is related works, introducing several examples of landscape and architecture visualizations as well as some relevant information visualization examples that inspire my works, with their corresponding pros and cons being discussed. The second part is conceptual framing, stating concepts and ideas grounding this thesis and how they evolve to form new ideas. Then those ideas are put into test as the first experiment, with its methodology and results being presented. Learning from some limitations of the initial experiment, the second experiment takes a different perspective looking at the topic by collecting, analyzing and visualizing data. Finally, general achievements, critiques and further development about this project are discussed in the last chapter.
Serenity in Chinese Garden

Photo credit: Cai Long
Chapter 2

RELATED WORKS

Closely related to landscape design and architecture, garden design shares similar ways of visualizing space and environment. Followings are some concepts, examples and technologies in landscape architecture visualization. As this thesis is going to focus on the visual aspects, especially colors, some examples of color-related and time-related information visualization will also be presented and analyzed critically.
2.1 Concepts and Visualizations in Landscape Architecture

2.1.1 Circulation

Circulation is one of the most important concepts in landscape design and architecture, and has an evident impact on people’s experience. In John L. Motloch’s *Introduction to Landscape Design* (Motloch, 2000), the author introduced some basic concepts regarding circulation. He mentioned that circulation works as “a means of structuring experience and as a generator of form”, because “we experience space temporally as a serial succession of perceptions, and from this sequence we develop an understanding of our spatial environment”.

Circulation can be seen as flow, and as visitors, our mood and experience are affected by characters of the flow we are following. For example, a meandering flow offers visitors apparently different perceptions compared with a direct flow – the former gives a melancholy feeling while the latter “imparts a sense of immediacy and purpose” (Figure 2.1). Influenced by many factors collectively, such as the width of path, attracting sceneries nearby and the crowd of people at that time, the character of flow is a significant part of design considerations at early stage in that it has an undeniable influence on visitors’ experience.

![Figure 2.1 Character of Flow](image)

Figure 2.1 Character of Flow
2.1.2 Visualizing circulation

Plan of landscape is a diagram illustrating general states of the place and design interventions by designers, and is commonly used for representing and communicating design ideas. Since garden is one type of landscapes, most of the rules and features used in landscape plans are also applicable for garden design.

Followings are a series of diagrams of the conceptual landscape masterplan for The Flower Garden Park in Ruichang, China (Chris Blandford Associates, 2013). The diagrams incorporate multiple layers of design and information (Figure 2.2). They illustrate how the circulation of the landscape works under different circumstances. Curves with different colors represent various circulation choices in the park, such as pedestrian paths, bicycle paths and other network paths. The circulation network and integrates circulation with people’s experience, as the paths provide a wide range of immersive experiences and opportunities that allow visitors to enjoy the flower scenes in the park. Those sinuous paths are designed in accordance with the gentle, flowing, undulating landform, and they are inspired by the organic form and structure of various flowering plants and their leaves. Meanwhile, there are several circles and dots in the diagrams to represent vantage points where visitors can appreciate some of the best views of the flower landscape amid the large context. Because this plan accentuates visual experience of color change on an annual basis provided by flowering plants, varied colors associated with different types of vegetation are also used in the diagram to illustrate the primary color of areas (Figure 2.3). The interlocking related colors between the primary and secondary paths (shown in the diagrams as heavy white curves and thinner white curves respectively) give visitors an opportunity to enjoy the undulating ocean of flowers.

However, this series of diagrams only show how the circulation is arranged from birds-eye-view, while neglecting how people actually experience in this place. Moreover, even though the color change is the highlight of this master plan, those diagrams do not convey the idea of changing color over time, which weakens the power of the diagrams and does not provide enough information for audiences. Besides, they are rather difficult to understand for general audiences and laymen.
Figure 2.2
Diagrams of Park Circulation

Figure 2.3
Relating Colors to Landscape
2.1.3 Technologies used in landscape visualization

Besides diagrams of plans, 3D modeling is another traditional and commonly-used way of visualizing design interventions and showing vignettes in landscape design and architecture. In recent years, as the development of technology, some cutting-edge visualizing techniques, such as augmented reality and virtual reality, are also applied to landscape visualizations.

This 3D model of Serpentine Pavilion designed by Bjarke Ingels Group is a successful example that allows audiences to interact with it (ArchDaily, 2016) (Figure 2.4). It provides three options of different perspectives: floorplan view, bird view and person view. Although rendering techniques and style of drawing may affect the results, the key is to ensure that audience can have a sense of being there, especially through the person view (i.e. perspective view) (Figure 2.5). Besides, this example also allows audiences to use virtual reality devices, which simulates real environment and offers more immersed feelings with people’s movement. Other great examples in this case include Google Earth and Google Street View. Such technologies connect artefacts with audiences in a vivid way, so that they can trigger people’s interests and capture their attentions, thus they are in a better position to help audiences to understand the works.
Figure 2.4  3D Model of Serpentine Pavilion (bird view)

Figure 2.5  3D Model of Serpentine Pavilion (person view)
2.2 Information Visualizations about Color and Time

2.2.1 Visualizations about color usage

Analyzing color usage can be a good way to study something that inherently has visual attributes, since everything has a fundamental visual attribute of color. This example, designed by Derek Chan and Front Page Fingerprint, is a visualization of the elements making up the New York Times front page, including white space, headline size/length, body copy, imagery and overall color palette (Plenty of Colour, 2011). There are 28 columns in total in the graph to represent 28 days of February, 2011, with each column representing the magazine front page of that day (Figure 2.6). By observation, it seems that the sequence of colors in each column is based on the proportion of colors, which means that colors with the largest proportion to the smallest proportion are plotted from top to bottom. Seeing from this visualization, there seems to be a pattern of color usage in different days of a week, for example, front pages on weekends are more likely to be more colorful than their weekday counterparts (Figure 2.7).

Actually, the “color pattern” of magazine is dependent upon the way of arranging colors to some extent. If those colors are arranged by their brightness instead of proportion, there might come a very different pattern. Nevertheless, this work extracts some hidden information about magazine front pages and visualizes something that is already visual, giving audiences a new perspective of “reading” magazines.
Figure 2.6
Visualization of Formal Elements of New York Times Front Page

Figure 2.7 Details of New York Times Front Page Visualization
Another visualization about color usage is “Visualization of Movies”, showing the color usage in movie *Batman Begins* (Dirksen, 2013). The designer used several libraries to extract a frame’s “average” color every couple of seconds, saturated the colors to make them look better and put them together in chronological order to form a colorful barcode (Dirksen, 2013) (Figure 2.8). Then those colors were organized from dark to light and plotted in a donut shape, with the width of a color segment corresponding to how much that specific color is used in the movie (Figure 2.9). But since some color saturation methods were applied in the series of visualizations, it is likely that the colors shown in the visualizations are not real colors in the movie. Even so, this series of visualizations give viewers a direct sense of basic tones in the movie, and make it possible to compare different movies from the aspect of color usage and visual experience to some extent.

It is apparent that, for those works that deal with color or other visual attributes especially, the way of organizing data or information plays a central role in how the results look like, which, actually, also holds true for any other information visualization.
Figure 2.8
Barcode of Color Usage in
*Batman Begins*

Figure 2.9
Donut of Color Usage in
*Batman Begins*
2.2.2 Time-related visualization

As the second experiment of this thesis focuses on the change of colors over time, it is necessary to know some conventional visualizing methods and visual forms about time-related visualizations. Of course, there are plenty of time-related data visualizations, ranging from common line charts to the well-known Charles Minard’s map illustrating Napoleon’s Russian campaign. In addition to those linear-shape visualizations, circular shape gives a more metaphorical sense of time to the visualization. In the infographic about traffic accidents in Netherlands (Figure 2.10), designer Nadieh Bremer divided a circle into twelve parts evenly to represent twelve months, and plotted information, including daylight hours (shown in blue areas) and holidays, on the circle, in order to indicate some relationship between the amount of accidents with holidays, for example (Bremer, 2015).

The circular form offers audiences a clear sense of the continuous and gradual change of daylight hours throughout the year. In most cases, the form of visualization is closely related to the content of visualization, just as the circle and time of a year. However, there should be a clear focus in term of the content, because too complicated and unfamiliar content would overwhelm or even frighten audiences. In this example, because the visualization integrates several factors related to traffic accidents and more information means more complexity, some legends of indicating roles of different lines should be more apparent to allow audience to notice them more easily.
Figure 2.10 Infographic about Traffic Accidents in Netherlands
2.2.3 Visualization about color change

When color usage is related with time, here comes the change of colors. Different colors are associated with different time throughout a year, especially when it comes to nature and landscapes due to the changing colors of vegetation. Following data visualization called Flickr Flow, designed by Fernanda Viégas and Martin Wattenberg, illustrates flow of seasonal colors of Boston Common, addressing both color and time (Figure 2.11). They collected photographs about Boston Common from Flickr, calculated relative proportions of different colors in each photo by an algorithm they created, and plotted those colors on a wheel (Viégas Wattenberg, 2009). Colors of summer are plotted at the top of the wheel, where obviously greenish colors become the primary hues, while opposite to the summer part, the large proportion of grey colors gives a hint of snowy days in winter (Figure 2.12).

This visualization reflects seasonal change of landscape by showing the change of colors, and the circular form also strengthens the idea that the color pattern cycles through the year, which is a very appropriate way of representing time. However, the designers did not clarify neither how the algorithm works nor the quantity of data, so it is hard to tell if those colors are real colors extracted from photos or they are modified in certain ways, and even harder to tell whether the four seasons are evenly distributed on the wheel. Nevertheless, this visualization provides a framework and inspiration for my later works.
Figure 2.11  Flickr Flow

Figure 2.12  Details of Flickr Flow Visualization
2.3 Discussion about Related Works

Learning from the examples discussed above, it is evident that different methods of visualization are used depending on what kind of situations they are addressing and what kind of results they want to achieve.

Among them, landscape plans and diagrams (as shown in the first part of this chapter) can provide a general view of the context and is a relatively more widely used visualizing method in the field of landscape design. However, those diagrams do not pay enough attention to people’s real experience in the place – even if several colors representing different circulation choices and sceneries in the landscape are assigned to the diagrams, they are just conceptualized colors and lack connections to reality. Furthermore, those diagrams seem too complicated to make them comprehensible for laymen and general audiences. Compared to idealization of diagrams, some visualizations about real-life information (as shown in the second part of this chapter) are more likely to reflect what the reality is, even though they are also subject to what designers want to convey. Both the visualizations about magazine front page and Boston Common, for instance, generalize visual aspects of specific subjects and offer a new perspective of looking at magazine and park. At the end of the day, no matter what topics are, the process of visualizing is basically the way of organizing information. And most importantly, there is few information visualization works exclusively designed for Chinese gardens.

Learning from these examples, in the next chapter, I will talk more about several concepts and ideas that ground and inspire my works and come up with my approach to balance different ideas.
Nowadays, there are hundreds of Chinese classical gardens in existence, including imperial ones and private ones, which share similar features in terms of their elements and structures. Among those gardens, I chose the Humble Administrator’s Garden (Zhuo Zheng Yuan, Suzhou, China) as a representative to look into. Built in the 16th century, it is considered as one of the four most famous Chinese classical gardens. With several well-known then contemporary artists and poets participating in designing process, the garden is among the highest artistic, aesthetic and architectural achievements in the field of Chinese garden design (Fang et al., 2010).

When it comes to visiting gardens, people’s experience in a certain place consists of several dimensions, including three dimensions of space, the fourth dimension of time and varied sensory experiences, such as visual and audible senses. Every dimension is made up of various elements. Take the three-dimensional space for example, it includes scale and proportion as well as a great number of elements such as plants, architectures and water areas. Because each dimension is interrelated with one another, each aspect needs to be considered as part of this relationship of interdependence. Furthermore, because of its complexity, it is still difficult and even impossible to take all the aspects into consideration at the same time. Therefore, in this thesis, I will choose some aspects closely related to visual experience and explore each of these aspects in light of this interplay, and look into how each aspect affects people’s experience in the garden and then experiment with different ways to analyze and visualize.

In landscape and architecture visualization, there are mainly two commonly-used viewpoints, namely bird’s-eye view and perspective view, with each one having its advantages and disadvantages. As bird’s-eye view provides an elevated view of an object from above, looking through bird’s-eye view obviously offers a more holistic picture about the overall situation and environment, thus it has its undeniable advantage in the making of maps and plans (Oxford
Dictionaries, 2017). But it is not the way people usually visit and experience a place. Perspective view, by comparison, is more closely related to where viewer’s vantage point is and what the viewer is actually seeing. Although image taken by perspective view resembles the original scene, it can be rather difficult to measure thus even harder to analyze.

Furthermore, visualizing methods and techniques also exert a significant influence on how results look like. In recent decades, there is a tendency that some cutting-edge technologies, such as augmented reality and virtual reality, will become increasingly widely utilized in the future, and indeed they have undeniable advantages over some traditional visualization methods. It is true that such methods provide audiences opportunities to acknowledge a place in a vivid way, however, overmuch information is unnecessary and might make people feel overwhelmed and even ruin the whole picture. In some cases, people need access to rather comprehensive information, while in other cases, getting to know one or two aspects is sufficient, which can capture people’s attention onto those aspects.

Given the problems mentioned above, in this thesis, I will experiment with these two views respectively, as shown in the following chapters, and create visualizations reflecting people’s experience in Chinese classical gardens to some extent. To be less ambiguous, this idea is different from “visualizing experience”, which addresses people’s all kinds of feelings. Rather, the visualization works in this thesis will be focusing on only one or two aspects instead of all. In the first experiment, I will simulate how circulation, particularly paths, in the garden impacts people’s visiting behavior through bird’s-eye view. Looking at plan of the garden can offer a relatively holistic picture of the situation. Furthermore, circulation, as one of the most important components in landscape architecture, has evident impacts on people’s experience towards a place. Our perception “is affected by the character, nature and speed with which we move, which is, in turn, influenced by the circulation path” (Motloch, 2000). After examining the results and limitations of the first experiment, in the second experiment, I will analyze dominant colors of photos taken in the garden from perspective view, and look into how people’s visual experience is influenced by seasonal change in the garden.
Color is one of the most important aspects when experiencing a place. In architecture, for instance, “color is used to emphasize the character of a building, to accentuate its form and material, and to elucidate its division” (Rasmussen, 1964). It also holds true, especially, when it comes to landscape. Large amount of vegetation in landscape makes it possible to show seasonal change through changing colors. So there is no wonder to say that what a garden looks like depends on the season when you visit it. In order to record such visual experience in a place, people usually take photos of what they are seeing from their own perspective. Moreover, since people make decisions of which objects should be recorded instead of others before pressing the shutter, it is seasonable to argue that photos can reflect what people believe worth experiencing and memorizing. Therefore, in the second experiment, I propose that analyzing and extracting dominant colors in photos taken in the garden is a feasible way to show people’s visual experience there.

In the end, I hope that the visualizations created in this thesis could provide people a new perspective of looking at the Chinese garden and help them to acknowledge something they did not realize before. This thesis would become a success if it could contribute to people’s understanding and knowledge about the Chinese garden.
Circulation is one of the most important concepts in garden design. Since people visit and experience a garden along paths, roads and trails, the major component of circulation, looking at the circulation is a reasonable way to understand the relationship between visitors and the place. Therefore, in this experiment, I will look into how the garden’s circulation, particularly paths, works in terms of people’s visiting behavior, and visualize the results based on plan of the garden. The primary technique used in this experiment is programming by Processing to simulate how visitors are wandering around the Humble Administrator’s Garden. In this chapter, I will present rationale and methodology used in this experiment, results of visualization as well as critical analysis about it.
4.1 Rationale and Methodology

When it comes to visualizing methods, there are various ways to emphasize different aspects from different angles to achieve corresponding purposes. Processing, without doubt, has several unique features that differentiate it from others. Being a programming language, Processing is designed for designers and aimed at visual prototyping, including simulating behaviors of element affected by its environment in a “lifelike” manner. The element is called autonomous agent, which “generally refers to an entity that makes its own choices about how to act in its environment without any influence from a leader or global plan,” according to *The Nature of Code* by Daniel Shiffman (Shiffman, 2012). And simulating wandering behavior is not simply moving randomly, but rather behaving in a way that moving towards a certain direction for a while before wandering to another direction. (Shiffman, 2012). The primary methods used here are from computer scientist Craig Reynolds, who developed a method of “algorithmic steering behaviors for animated characters” (Reynolds, 1999). The basic idea is to assign forces to objects (i.e. agents). According to *Newton’s Laws of Motion*, once a certain amount of force is added onto the object, the velocity of the object will be changed if the vector sum of the forces is not equal to zero. When an agent is in an environment where there are many forces with different directions and values, the agent will move according to the combination of both its own original state and influences from the environment.

Below I will talk about how this theory is applied in this case.
4.2 Process and Results

The basis of this experiment is plans of the Humble Administrator’s Garden, among which the primary one is from *Understanding Architecture* and drawn by Leland Roth (Figure 4.1), and other versions of plan found on the internet as supplements (Roth and Clark, 2013).

First of all, I drew the plan in Adobe Illustrator in order to vectorize it and make it more convenient to use in later steps. At the same time, different elements in the garden were assigned with different colors: water areas are blue, architectures are grey, plants are green, paths are dark grey and background is light green (Figure 4.2).
In the following steps, coding in Processing is the primary technique for visualization. Firstly, those vector paths were loaded into Processing, before converting them as a set of coordinates that can be displayed and used later. Next, three agents (i.e. circles in visualization) in different speed and force are generated for each path segment (the number “three” is an arbitrary choice and we can change that if we want). The force here means there are certain constraint and freedom assigned to each agent. As each moving circle (i.e. “Vehicle” in code) represents a person or a group of people, assigning them with different initial speed and force is to make sure them behave like people – since everyone’s pace of visiting a place is different from others. And the values of speed and force set in this experiment are from lots of testing and chosen as the results of having the most appropriate visual effects. Figure 4.3 is the screenshot of the code in Processing where the speed and force are set. “The vehicle should look at how it desires to move (a vector pointing to the target), compare that goal with how quickly it is currently moving (its velocity), and apply a force accordingly” (Shiffman, 2012). Then, a path following algorithm is implemented to make sure the agents are following their corresponding path within certain sphere. Figure 4.4 shows the function in the code implementing the algorithm.

```java
//Add vehicles to each child path of the AllPaths
for (int c = 0; c < loadedPath.GetChildCount(); c++){
    //Get coordinate of the first point on vector
    PVector first = AllPaths.get(c).getStart(); //"getStart" is a function

    //Each vehicle has different maxspeed and maxforce
    car1 = new Vehicle(first, 0.2, 0.01);
    car2 = new Vehicle(first, 1, 0.01);
    car3 = new Vehicle(first, 0.5, 0.05);

    //Add this agent to the AllVehicle
    AllVehicles.add(car1);
    AllVehicles.add(car2);
    AllVehicles.add(car3);
}
println("size of AllVehicles: "+AllVehicles.size());
println("first vehicle: "+AllVehicles.get(0));
```

Figure 4.3 Code in Processing about Setting Speed and Force
Figure 4.4 Code in Processing about Path Following Algorithm

```java
// This function implements Craig Reynolds' path following algorithm
void follow(Path p) {
    // Predict position 50 (arbitrary choice) frames ahead
    // This could be based on speed
    PVector predict = velocity.get();
    predict.normalize();
    predict.mult(20);
    PVector predictpos = PVector.add(position, predict);

    // Now we must find the normal to the path from the predicted position
    // We look at the normal for each line segment and pick out the closest one
    PVector normal = null;
    PVector target = null;
    float worldRecord = 1000000;  // Start with a very high record distance that can
    // Loop through all points of the path
    for (int i = 0; i < p.points.size()-1; i++) {
        // Look at a line segment
        PVector a = p.points.get(i);
        PVector b = p.points.get(i+1);

        // Get the normal point to that line
        PVector normalPoint = getNormalPoint(predictpos, a, b);
        // This only works because we know our path goes from left to right
        // We could have a more sophisticated test to tell if the point is in the line
        if (normalPoint.x < a.x || normalPoint.x > b.x) {
            // This is something of a hacky solution, but if it's not within the line segment
            // consider the normal to just be the end of the line segment (point b)
            normalPoint = b.get();
        }

        // How far away are we from the path?
        float distance = PVector.dist(predictpos, normalPoint);
        // Did we beat the record and find the closest line segment?
        if (distance < worldRecord) {
            worldRecord = distance;
            // If so the target we want to steer towards is the normal
            normal = normalPoint;

            // Look at the direction of the line segment so we can seek a little bit ahead
            PVector dir = PVector.sub(b, a);
            dir.normalize();
            // This is an oversimplification
            // Should be based on distance to path & velocity
            dir.mult(10);
            target = normalPoint.get();
            target.add(dir);
        }
    }
}
```
There were a lot of back and forth as well as trial and error before making sure all the code running properly. Next, I loaded other elements of the plan (i.e. the plan except for the paths) as background into Processing as well, and resized it to ensure the two parts of the plan are in the same scale. In the last step, several attributes of visual elements, including stroke weight, color and opacity, were adjusted to make the visualization legible. Result of the whole process is an animated visualization, with circles moving along the paths. A screenshot of the visualization is shown in Figure 4.5.

Figure 4.5 Screenshot of the Visualization
4.3 Analysis of the Results

It took lots of efforts to make the program running properly and ensure those little circles moving around the garden. This visualization achieves the goal of visually showing how the circulation in the garden works. But clearly, there are some agents wandering off the paths and not working properly as they should be, which is due to some flaws in the algorithm of generating agent.

Relating to my research objectives, which is to help people to have a better understanding of the garden from the angle of visitors’ experience, this experiment illustrates how circulation (paths, to put it more precisely) of the garden affects visitors’ experience in a detached way, and it simulates visitors’ visiting behavior visually. Besides, it also visualizes how people are using the garden, which gives an implication of which area is more accessible than other areas from an idealistic aspect.

Apparenty, there are also some limitations in this experiment. Although this experiment began from the aspect of “circulation” and entitled as “circulation visualization”, it, however, only touched the surface of circulation, which actually is a very huge and broad concept in landscape design. Apart from paths, various elements, including vegetation and topological conditions, in the garden are also indispensable components of circulation. And the more I read and know about this field, the more I get realized that it is indeed not enough to analyze a garden in two-dimensional perspective. It is true that many information can be acquired from the bird’s-eye view, such as looking at plan just as what this experiment does, but in other cases it becomes necessary to tackle problems in perspective view, which is how people experience a place in reality. Therefore, there is no doubt that the method of only analyzing plans is rather limited, since it is the spatial relationships that circulation and garden design deal with. Besides, since this experiment simulates and visualizes an idealistic situation, it is too abstract to reflect what the garden looks like and how visitors feel in real life.

Therefore, in the next experiment, I will analyze the garden from perspective view and further focus on people’s visual experience.
Our perception of the world is formed as we move from place to place.

—— from *Introduction to Landscape Design* by John L. Motloch
Chapter 5

EXPERIMENT 2:
Visualizing Seasonal Change in Garden

This experiment focuses on people’s visual experience, especially colors, in the Humble Administrator’s Garden through analyzing photos taken in the garden. In this chapter, I will first talk about the rationale of this experiment, then introduce the data-collecting process and the way of visualizing them before presenting the results.
As several key concepts and ideas stated in the chapter of Conceptual Framing, photo-taking is one of the most commonly used way of recording people’s experience and memory in recent decades, and photos play an irreplaceable role in sharing experiences with family and friends. Every photo is a reproduction of the reality thus it comprises a great amount of information about the place at that time, ranging from visual quality to photographers’ feelings. In the field of landscape research, assessing photos also is an important approach. “Photographs have long been used to represent environmental conditions in the context of landscape quality assessments and environmental perception research” (Daniel and Meitner, 2001). Owing to the rich information that photos contain and their unique role in landscape research, in this experiment, I will start from photos and use them as the source of data.

Among various kinds of information that photos provide, color is one of the most direct features. Colors of a photo are able to reflect different visual qualities of objects shown in the photo, such as light, weather and time. Even though colors tend to be altered depending on the equipment used and the skill of photographers, they are the results, to some extent, of interaction between the focused objects, environment, camera and people. So assessing colors is a reasonable and viable way to analyze and acquire information of photos. If colors of photos are associated with date when the photos are taken, it becomes possible to reveal the color-changing of a place over certain period.

The method used in this experiment to assess colors is extracting color pallet from a photo, in order to detect a set of colors that capture the mood of the image (Nedrich, 2016). Since each pixel of a digital color image can be represented in RGB format (red, green, blue), it becomes possible to plot each pixel in a three-dimensional RGB color space and represent colors in a mathematical way. Figure 5.2 is a three-dimensional RGB plot of pixels in a photo shown in Figure 5.1. If the colors of an image are embedded in an RGB space, the distribution of the pixels can be analyzed to detect the most prominent colors. There are many different approaches to calculate the distribution. In this experiment, an approach called \textit{k-means} is utilized. \textit{K-means} is a standard clustering algorithm.
that attempts to partition a data set into \( k \) clusters. In the k-means algorithm, the number of clusters that the input data is split is determined by an input parameter: \( k \) (Nedrich, 2016). In other words, the value of \( k \) determines the number of color extracted from the image. Compared to other methods, k-means is reasonably performant and also simple to implement (Nedrich, 2016; Walker, 2016). In this experiment, I set \( k \) to be 3 to extract three dominant colors from each photo, because too many colors would be too detailed to give a general idea about the tone of the photo, while one or two colors would not be sufficient to reflect the real-world tones (Figure 5.3). An online application called Palette Maker, developed by Matt Nedrich, is the main tool used in this experiment to extract dominant colors (Nedrich, 2016).

Next, I will talk about the detailed process of acquiring data from photos, including steps of collecting photos and analyzing them.

Figure 5.1 Humble Administrator’s Garden
(Photo Credit: Andrew Parmanand https://www.flickr.com/photos/andrewparmanand/8194932724/)
Figure 5.2
Three-dimensional RGB Plot of Figure 5-1

Figure 5.3
K-means Pixel Clustering
5.2 Collecting Data

Data-collecting process began from collecting photos. First of all, it is a central step to choose a reliable platform where authenticity of photos is guaranteed and information of photos is provided. In other words, photos should, at least, be about the research subject of this thesis, the Humble Administrator’s Garden. There are, of course, many online photo sharing platforms that meet this requirement, such as Google Images, Instagram and Flickr. Among many platforms, I decided to use Flickr (https://www.flickr.com/) as the source of photos. One of the reasons of choosing Flickr is that photos on Flickr provide their geolocations that ensure the photos were taken in the garden, while Google Images as an image-searching tool does not provide such information. Besides, since this experiment is meant to relate colors to seasonal change, it is necessary for each photo to contain information of date when the photo is taken. However, Instagram, probably the most popular photo-sharing social network nowadays, only shows posting date, which is not necessarily the same as date taken. Out of the reasons stated above, Flickr was selected as the source of photos.

In Flickr, there are several ways of searching images, such as searching by map and searching by keywords. In fact, the results of these two means are quite similar, except that the former shows searching results on a map. Another way is searching by tag, the results of which include some photos that do not contain the keywords in titles or descriptions, because tags can be added by other users. It appears that searching by tag is a relatively more valid and comprehensive way. Therefore, I decided to use searching by tag as the main method, supplemented by searching by keywords.

Another important factor influencing searching results is the way photos are sorted. Flickr provides four options of sorting, which are sorting by relevant, by date uploaded, by date taken and by interesting. The first option tends to include various types of photographs, especially many figure photos. The second and third options put most recent photos on the top thus cannot provide photos with widely-ranging dates, accordingly only limited number of users are included. As for sorting by interesting, Flickr does not clarify how this sorting method works, but by observation, it seems that Flickr presents on top those images that are more appealing and with more favorites and views. It ensures that photos from more users are included, and date taken also varies. Moreover, as the title of this sorting method means, it can reflect people’s preference to some extent. After
weighing pros and cons of all the four options, the way of sorting by interesting was chosen for this experiment (Figure 5.4).

To sum up, according to the researches discussed above, photos used in this experiment are from the searching results on Flickr, and they should contain the tag of “Humble Administrator's Garden”. Followings are some criteria of selecting photos. First, each photo should be directly related to outdoor sceneries of the garden, which means people or other irrelevant objects are not main focus, because garden is the subject of this project. Secondly, each photo should be chromatic, excluding photos that are black-and-white or exerted filters to make them monochromatic (Figure 5.5). This is an essential requirement, since “color” is a key factor here. Thirdly, each photo should have information about date taken, not uploaded, in that these two dates are different in some cases and it only makes sense to connect real situation of the garden to date taken. In order to meet all these criteria, I selected photos by myself manually.
Next, each photo was analyzed by Palette Maker to extract three dominant colors. For each color, both color code and corresponding percentage were collected and recorded in Excel. Sequence of the three colors of each photo is based on their proportions, which means that color with the largest proportion is assigned with “color1” and color with the least proportion is assigned with “color3”. And “percent1” is the corresponding percentage of “color1”, and so is “percent2” and “percent3”. 100 photos were selected and analyzed in total, with 25 photos for each season (spring: March to May; summer: June to August; fall: September to November; winter: December to January). Rows of data are grouped by season, and are rearranged by date taken, where only month and date are considered.

Figure 5.6 shows a screenshot of part of the data set.

In order to observe photos directly, I listed all the photos and made a photo grid of all the 100 photos collected, organized by the date taken, as shown in Figure 5.7. Photos with horizontal orientation are resized into the same height, and photos with vertical orientation are rotated 90 degrees before being resized into the same height with others. The grid gives a direct sense of the changing tones of photos taken throughout four seasons, and also works as an initial attempt of visualization.

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Figure 5.6 Part of the Data Set
Figure 5.7 Photo Grid of All the Photos
Given the data set collected, it is a key step to choose an appropriate way to visualize it. Below I will present three different ways of visualizing the data.

As each row of the data shows information about that specific photo, it is a natural and intuitive approach to group and visualize the information by photos, which are rows in the data set. In the chapter of Related Works, the example of visualization about New York Times front page also uses the similar approach, showing colors of each front page in column. Therefore, I adopted this linear form of visualization as the first attempt. Every column, representing one photo, is divided into three sections based on the percentage of corresponding color. Color with the largest proportion (i.e. “color1” column in the data set) is plotted in lower part of the column, and color with the least proportion (i.e. “color3” column in the data set) is plotted in the upper part. Because both width and height are the same for each rectangular column, the height of rectangle for each color means its relative proportion and different photos can be compared directly. All the columns are aligned from left to right according to their dates taken and corresponding seasons from spring to winter. Since it would be too heavy a work if manually processing a hundred rows of data, the visualization was achieved through coding by p5.js, a JavaScript library (McCarthy, 2017). There is no doubt that coding is a relatively convenient way to visualize a large quantity of data. Result of this visualization is shown in Figure 5.8.

Figure 5.8 Visualization of Seasonal Change in Garden (rectangular form; organized by proportion)
The rectangular form illustrates color bars in a linear way, giving audiences a direct sense of change of colors throughout four seasons, however, it lacks continuity of this change. In other words, the start of spring is just one day away from the end of winter if separating seasons by month, and there is not much difference between the two. Therefore, it makes more sense to make those colors in a circular form so that every season is adjacent to the other two seasons that are preceding or following it. Moreover, circular form also implies the metaphor of seasons cycling all year round and all the time. Many time-related information visualizations also use circles, just as the examples of infographic about traffic accidents and “Flickr Flow” discussed in Chapter 2. Out of these reasons, in the second attempt, I chose circular form to visualize the data.

The basic idea of plotting colors in a circle is that the circle is evenly divided into 100 circular sectors, and each circular sector is further divided into three parts for three dominant colors of one photo. The way of dividing each circular sector is, actually, the way of relating data to visual form. Basically, there are two ways of dividing each circular sector: the first approach is dividing based on radius, which means proportions (i.e. “percent” columns in data) of colors are related to proportion of radius segments; the second approach is dividing based on area, which means proportions of colors are related to divided areas. It is obvious that the latter, by comparison, is more reasonable than the former, because it is a norm and natural tendency for people to associate area of a two-dimensional shape with quantity and make comparison. Furthermore, using area to represent data can give people a quick and overall view of how big or small the data is, especially when the areas are colored. So three dominant colors of every photo is plotted in one circular sector according to the formula for area of circular sector, and the color with the largest proportion is near the center while the color with the least proportion is at the edge of the circle (Math Open Reference, 2017). Meanwhile, all the data from spring to winter are arranged clockwise from top. As shown in Figure 5.9, the upper right, lower right, lower left and upper left parts of the circle represent colors in spring, summer, fall and winter respectively. Same as the rectangular visualization, this one was also achieved by coding in p5.js.
Figure 5.9
Visualization of Seasonal Change in Garden (circular form; organized by proportion)

The circular visualization addresses the continuous change of colors throughout the year, but there are still some aspects that could be improved in terms of its visual form. Because the circle is divided into 100 sections, the central angle of each circular sector is very small (3.6 degree) and there creates a very pointed end towards center of the circle. Moreover, circular sectors with small central angle are pretty similar to triangles, which inherently have a special character of direction. 100 circular sectors pointing to the center at the same time directs people’s attention to the center, while neglecting the edge of circle where change of colors is more clear and vibrant. Fortunately, donut shape is able to retain the benefits of circle and meanwhile eliminate the drawbacks of pointing to center. Therefore, based on the circular visualization, donut shape is applied to the third visualization attempt.
The algorithm of donut visualization is similar to the circular one, such as calculating radius of each color sector according to its percentage of area, except that the size of “donut hole” needs to be taken into account. Same as the previous visualization, three dominant colors of each photo are organized by their proportions from the largest to the smallest and plotted from center to edge. Figure 5.10 shows the result of the third visualization.
5.4 Reorganizing Data and More Variations

How visualization looks like largely depends upon how information is organized. If the original data set is organized in other ways, there is no doubt that more variations will be created even if the algorithms remain the same. With the hope of finding a more appropriate way to visualize the data, I tried a different way of organizing data.

In the original data set, the order of three dominant colors is based on their respective percentages, and so are the visualizations. Although such order makes it easier to know which color accounts for relatively large proportion in one photo or between different photos, some colors with lower lightness, such as white and light green, seem rather intrusive among other dark colors. Meanwhile, those intrusive colors interrupt a continuous change of colors whether for one column or for the whole sequence of columns, thus make it difficult for audiences to get a clear sense of the seasonal color change throughout a year. Therefore, I reorganized the data manually to ensure the three colors of each photo are arranged by their perceived lightness.

Using different order of data but the same visualizing algorithms and methods, more variations are created. The first variation is in rectangular form, with colors arranged from dark to light for each column from the bottom to the top (Figure 5.11). Since the donut shape visualization shares similar algorithm and appearance with the circular one but works better than the latter, here only presents the donut shape variation, as shown in Figure 5.12. This variation organizes colors from dark to light on the wheel from the center to the edge. In these two variations, the change of colors looks more continuous and smooth than previous ones as expected, and they are also more harmonious in visual aspects without abrupt colors.
Figure 5.11 Visualization of Seasonal Change in Garden (rectangular form; organized by lightness)

Figure 5.12 Visualization of Seasonal Change in Garden (donut shape; organized by lightness)
5.5 Analysis of the Results

The visualizations presented in this experiment, no matter in rectangular, circular or donut shapes, illustrate seasonal change of colors from people’s perspective, reflecting people’s visual experience in the Humble Administrator’s Garden. From Figure 5.11 and Figure 5.12, we can clearly see that there is a continuous and gradual change of colors throughout one year. In landscape, change of colors basically owes to changing color of vegetation, which also holds true for gardens. In spring, there are some yellowish green colors followed by bright green, because trees begin to bud around March and some photos captured burgeoning willows in the garden. Colors become varied in summer, with greenish colors accounting for a large proportion. Various vegetation is flourishing during summer and many lotus flowers are blossoming around August, which is why there are some pink colors in the visualization. In fall, we can find that there are even more vivid and diverse colors, which is due to various colorful flowers and yellow leaves on deciduous plants. As for winter, the garden is mainly dominated by grey and other dark tones, except for photos of snowy days where white is the primary color. Figure 5.13 shows the visualization annotated by corresponding photos.

In addition to change of vegetation, some characteristics of the garden can also be revealed by those colors. Seen from Figure 5.8 where colors are organized by their percentage, it is obvious that dark colors account for the largest proportion in most photos, which can be caused by many reasons, for example, insufficiency of light in environment or skill of photographers. But from the aspect of the garden itself, lots of elements in the garden have a quite large proportion of dark colors. Architectures, one of the four primary landscape elements in Chinese garden, in the Humble Administrator’s Garden nearly all have black roofs, which is regarded as a symbol of private gardens in southern China and a special feature differentiating them from their imperial counterparts. Since the garden is particularly well-known for water, there is no wonder that green ponds and other water areas in the garden lead to a large amount of greenish dark colors in the visualizations. In the sphere of the built environment, “color may express the character of a building and the spirit it is meant to convey” (Rasmussen, 1964).

Colors with large proportion can imply the basic tone of the garden, while colors with smaller proportion are able to reveal some hallmarks of both the garden and the culture behind it. Pink appears quite frequently around summer and fall, which is due to lotus flowers as I mentioned before. Inherently associated with
Figure 5.13  Visualization Annotated by Corresponding Photos
Buddhism, lotus flower is an emblem of purity and truth in Chinese culture, providing inexhaustible inspirations for poems and paintings. As for some yellow and orange colors in fall, some of them are derived from chrysanthemum, which is also one of the most important cultural symbols in China and signifies intellectual accomplishment and longevity of life (Koshoibekova, 2014). Just as Rasmussen suggested in *Experiencing Architecture*, “the colors were regarded as symbols,” and “on the whole, color, to most people, has always been highly symbolic” (Rasmussen, 1964).

Furthermore, the colors people see in the garden exert subtle yet undeniable impacts on people’s emotions and mood. According to color phycology studies, “color may also influence a person’s mental or physical state” (Art Therapy, 2011). Green, for instance, as a primary color of the garden during more than half of a year, indicates the presence of water and plants and implies balance and harmony of nature, so people might feel reassured by green (Colour Affects, 2017). Nowadays, the development of color therapy offers a theoretical guideline for an increasing number of color-related landscape design. And garden, without any doubt, is a place where people relax themselves and find inner balance.

Of course, there are still some limitations in this experiment. Basically, most limitations come from the data itself, which is rather hard to avoid. Even though a series of criteria were applied when selecting photos, it is impossible to guarantee that those photos are able to show the colors as in real life. Photos may look different even if they are from the same photographer but taken by different cameras. Moreover, it becomes a norm to edit photos by filters before posting them online, which changes tones of the photo to some extent. Although the manually selecting process can remove most unqualified photos (black-and-white or monochromatic), sometimes it is rather difficult to tell whether they have been modified in some way. There are some limitations in the step of analyzing photos as well. The algorithm of k-means inherently averages colors so that some distinctive colors are likely to be ignored, which might lead to losing some important information. If more colors are extracted from each photo, there might be a different result. Besides, I have to admit that my personal preference towards both photos and the garden also influenced the photo-selecting process more or less. And because sometimes the structure and form of the garden and architectures can exert more impacts on people’s feelings than tones, by focusing on colors, this experiment addresses only part of the visual experience.

Overall, despite of some minor flaws, the goal of showing people’s visual experience regarding seasonal change of colors in the garden is achieved through collecting and visualizing data. Further discussion in the scope of the whole thesis will be presented in the next chapter.
Each way that you organize information creates new information and new understanding.

—— from *Information Anxiety* by Richard Saul Wurman
Chapter 6

DISCUSSION

Starting from the research question of how people experience the Chinese
garden, this thesis takes the Humble Administrator’s Garden as a representative
and explores the question from different perspectives in two experiments.

The first experiment examines how people visit the garden through simulating
garden circulation from bird’s-eye view. It gives a holistic picture of the way
people experiencing the garden physically by visualizing visitor’s movement.
This can be considered as the prelude to further exploration and experiences
of the garden in a deeper sense, since “the movement of our bodies through a
garden can be a powerful agent for meaning” (Herrington, 2007). Regardless
of what meanings the garden boasts, visitors get to know the place in their own
eyes. So the second experiment looks into how people visually experience the
garden by analyzing photos taken there. Dominant colors extracted from a
series of photos reflect and depict seasonal change of the garden from people’s
perspective, and also reveals some unique characteristics of both the garden
and the culture behind it. These two experiments tackle the research question
from different angles, and together serve as an exploratory study of the Chinese
garden.

The contribution of this work is that it integrates people’s experience with the
garden and fills out the blank of information visualizations specifically about
Chinese gardens. This work, especially the second experiment, illustrates the
garden under the influence of seasons and conveys beauty of the classical
Chinese landscape in a rather abstract yet straightforward way. It enables
audiences to catch the changing tones of the garden with a glance, as well as
provides a chance to dig into the objects and their deeper meanings hidden
behind the colors, thus results in a better understanding towards the garden.
Moreover, since colors have subtle yet evident impacts on people’s emotions,
such visualization of seasonal color change could provide material evidence for
landscape research and evaluation about visual perception.
As most information visualization works, the process of both collecting data and analyzing data plays a significant part in this thesis project. However, data itself inherently has limitations, which is unavoidable and beyond designers’ control. What a designer can do is trying to find an appropriate way to visualize the existing data. Since time is rather limited for the whole thesis project, there is still many aspects could be improved and explored in this topic. For instance, instead of doing it manually, automated solutions of acquiring and assessing photos could be used in the second experiment, which is much more efficient to deal with a larger quantity of data. Also, as for future works, if more gardens are analyzed and visualized in this way, there would create a series of color patterns about Chinese gardens and can offer a new perspective to make comparisons between different gardens.

Gardens, as well as any other things, are rich of information that is waiting to be discovered. Whatever the information is about, it is certain that it can be revealed and presented to audiences through visualization.
References


VISITING, PICTURING AND EXPERIENCING THE CHINESE GARDEN

by Muhe Yang