Research on the Application of Computerized Parametric Design in the Site Selection Analysis of Pocket Park Design

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Abstract. The unique park form of a pocket park makes its site selection a difficult part of its design. Using the computerized parametric design method, the grasshopper plugin in Rhino is used to calculate the location of the pocket park in the city by constructing the association between the residential area and the high interest site in the city, based on the crowd analysis, to improve the accuracy and scientifically of the location of the pocket park design, to realize the limited area of each pocket park to meet the location of the functions of each pocket park are divided within the park in a cluster mode.

Keywords: Parameterized · Pocket Park · Design Site Selection · Grasshopper · Pedestrian Simulation

1 Introduction

In recent years, computerized parametric design has been extensively used in the design field, and computerized parametric design was initially used by designers in the field of 3D modeling. Nowadays, as the basic urban data have been gradually collected, the pre-design location spatial data are completed enough to make use of everyone. In the past, the study of parametric design has focused on the design itself, such as the layout, form, materials and other elements, and less on the pre-design location analysis. However, because of its irreplaceable park form, the location of the pocket park is one of the most important factors in the design. At present, site selection analysis for pocket park design is mostly based on an on-site survey at this stage, and the results of short time survey may not be accurate. The purpose of this paper is tantamount to explore the assistance of computerized parametric design to the site selection analysis of pocket park design, and to improve the scientific and accuracy of pocket park site selection.

2 Pocket Park

2.1 The Basic Concept of the Pocket Park

The concept of pocket parks was first introduced in 1963 by Robert Zion, and the original idea was to systematically create small, patchily distributed parks in the heart

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of high-density urban areas [1]. Located between gaps in buildings, these parks vary in size depending on the available open space, and their primary function is to provide a minimum amount of space for nearby residents, workers and visitors to meet and rest.

2.2 Features of Pocket Park

The pocket in the pocket park has a triple meaning, and the meaning of these three pockets also represents the characteristics of the pocket park.

Firstly, the pocket means that it has a small land area and can even be put into a pocket park, which is a type of rhetoric but also reflects its connotation. Secondly, it means that it is as essential as a pocket in people's life, as a small urban public open space, providing a place for public relaxation and entertainment in people's urban life, regulating land use density and beautifying the environment [4]. Lastly, it is highly accessible and convenient, just like a pocket, providing people with convenient access to it.

2.3 Location of Pocket Park

Pocket parks have three different site selection ideas. The first is to transform street-side green space, the second is to transform urban open space, and finally is to merge slow-moving streets, transforming intersections and roads into pocket parks by merging several streets and banning motorized traffic within the blocks [3].

(1) Transforming street-side green space is the most common way of siting pocket parks, but such pocket parks often retain only basic landscape and resting functions, and have almost no functions for further recreation, pollution purification, elderly health care, children's play, ball or sports topics.

(2) Some pocket parks are built on vacant land in the city and are inevitably designed to meet very tight space constraints. When a small pocket park cannot provide enough space for residents, workers and visitors, a parametric design of the pocket park network comes in handy. Through the parametric analysis, groups of open space around the site are selected, and these groups of pocket parks are co-designed to provide a complete park service for these areas with limited land area, while retaining the basic functions and highlighting the different functional characteristics of different pocket parks.

(3) It is the most complicated to select the site for the pocket park of a merged slow-moving street, because both road planning and citizens' wishes have a great influence on the transformation, so it is the most difficult to design the pocket park of a slow-moving street, and there are almost a few precedents in China. However, a parametric simulation design combining demographic information and urban road information can be the most scientific way to select a suitable site for merging neighborhoods.

3 Computer Parameter Design

3.1 The Concept of a Parameterized Design

Parametric design is a design method that involves programming algorithmic mind into design. By organizing all aspects of the conditions and factors effectively, using defined

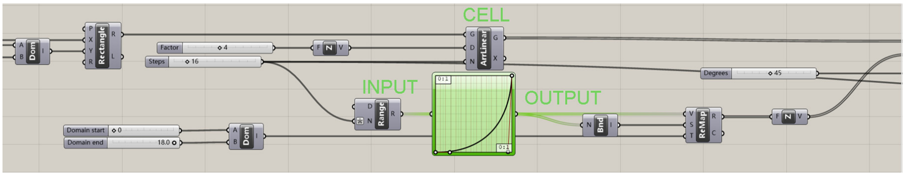


Fig. 1. Grasshopper parameterized operator programming logic

rules and combine coding to realize visual design [5]. Parametric design is not only a tool used to make surface modeling, but also a design method to explore innovative design concepts and expressions through visual programming, establishing logical rules, and adjusting variables.

3.2 Parametric Tools: Grasshopper Plug-In Based on Rhino

Rhino is a powerful 3D modeling software. Originally utilize for industrial design, Rhino is increasingly being used in other directions as technology advances and industry evolves [2].

With the rapid development of parametric design, one of Rhino's parametric design plug-ins, Grasshopper, has also been slightly improved, although it is a plug-in for Rhino, it is completely different from Rhino's operational logic. The "cells" in Grasshopper are the equivalent of packaged programming language commands, and the user only needs to control the key variables of the "cells" to create the model. Grasshopper's design logic is intuitive and fast, using the "cell" as the modeling language (Fig. 1).

3.3 Functional Uses of Grasshopper

Grasshopper, based on the "cell" model, is extremely extensible, and there are many plug-ins derived from it. These plug-ins include all the modeling and editing functions of conventional modeling software, as well as such functions as Kangaroo simulation mechanics and Karamba finite element analysis [6]. The most significant ones for pocket park site selection are Elk and PedSim plug-ins. Among them, Elk can model based on open source map data, and PedSim can work with each self-defined data for pedestrian analysis.

4 Parameterized Analytical Model of Pocket Park Site Selection

In a normal pocket park design site selection, the designer will use on-site surveys to conduct a cursory exploration and analysis of the site's surroundings. Due to the time constraint, this type of analysis is often done once or twice by random factors, and its accuracy cannot be guaranteed. After importing the data into the parametric design simulation based on the on-site surveys, a number of computer simulation will make the analysis results more accurate and scientific.

4.1 Study of Parameter Variables

In parametric pedestrian simulation, the factors that have influence on the simulation results are mainly people factors, road factors, and interested points [7]. Therefore parametric modeling is preceded by some preliminary preparation to conduct the initial investigation of these factors.

Firstly, the population, age structure, residential location and travel destinations of the area indirectly impact the location and functional design preferences of the pocket parks in the area. The parametric design cannot be built on one factor alone, rather multiple information must be combined to ensure the scientific and accurate simulation.

(2) The road factor means the road information in the existing map, such as the route information of city arteries, sidewalks, and community entrances and exits. Parametric pedestrian simulation can only be started when this basic information is available.

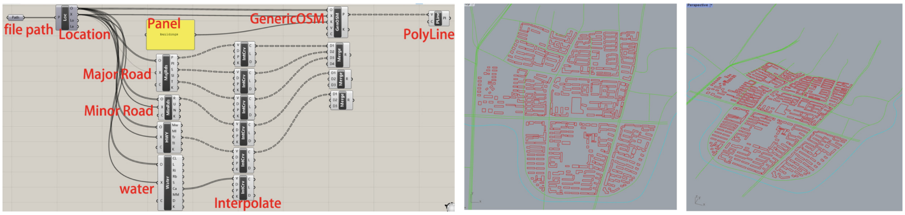
(3) Points of interest are also important factors influencing the pedestrian simulation. Miniature shop, bus stops, malls, restaurants, etc., which are attractive points of interest in people's daily lives, are the random variables in the simulation [8]. These points of interest are not the destinations of all pedestrians, and the pedestrian simulation is weighted by random variables for each pedestrian to reproduce the daily behavior of people in reality as much as possible.

4.2 Parameterized Model Construction

After the preliminary preparation, the pedestrian simulation can begin. In the PedSim, the pedestrian moves along the optimal path from the Start Gate to the Destination Gate. During the movement, the pedestrian avoids obstacles and other pedestrians on the road. If people see a target point of interest during walking, they will also walk towards the target point, stay for a while and then re-route the path to the destination point. Simulated pedestrian routes can be constructed based on this logic.

First is the creation of the base map, export the data in OPEN STREET MAP, then go into Rhino and open Grasshopper, create the file path, import the OSM data into the file path. Add Location, export path to Location, and GenericOSM, Major Road and Minor Road, export Location to them. Creating a Panel, change the content of buildings and export to GenericOSM. Make a PolyLine, export GenericOSM to PolyLine and BAKE PolyLine in a separate layer. Create an Interpolate, export all other road "cells" to Interpolate and BAKE them to a separate layer. At this point all map data are created in Rhino and can be used not only in Rhino but also exported to CAD files (Fig. 2).

The second step is to perform PedSim, which starts with setting the points of interest, start points and destination points. Use Gate to set the start point and destination point, and then use Program to make the interest points and label them with colors respectively. After that, PT was used to create a person template, Vision was used to set the pedestrian vision, Target was used to set the interest point, Curves was used to pick up the previously drawn base map, the number of pedestrians was set, Button and Trigger were added and output to PedSimulationSystem together with PT, so the first pedestrian template was built. Then set separate starting points, destinations, points of interest and other features according to the crowd characteristics (Fig. 3).



(a) Elk map builder plugin (b) Rhino top view (c) Rhino Perspective view

Fig. 2. The process of building a map in Grasshopper

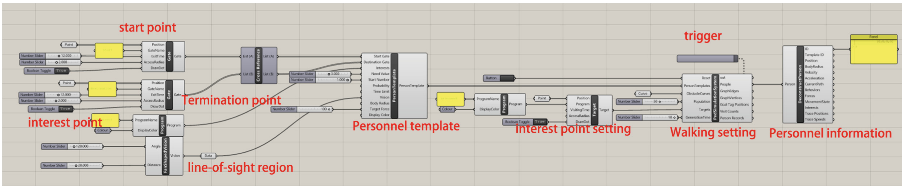
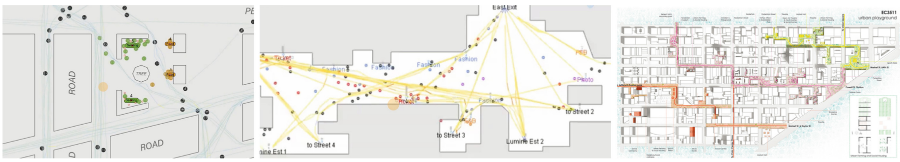


Fig. 3. PedSim personnel template builder



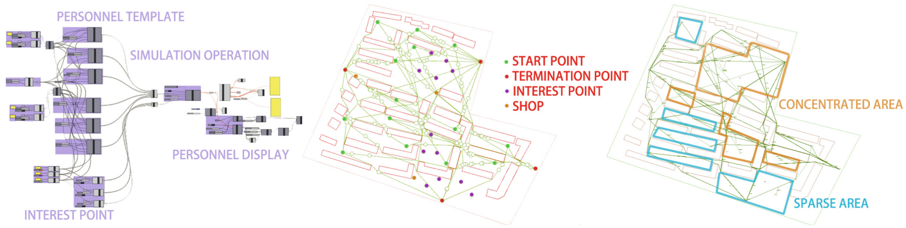
(a) PedSim process (b) PedSim results (c) Create a site analysis map

Fig. 4. Results of parametric pedestrian simulation

After creating all the pedestrian templates, click on trigger to run the program, observe the live pedestrian simulation process in Rhino and keep the curve, so that the pedestrian simulation modeling using PedSim plug-in is completed, and select the location for building the pocket park based on the simulation results (Fig. 4).

4.3 A Parametric Site Selection Analysis of Pocket Parks in Shenyang City

Take part of the parcel in the community of Huaxiang One, Tiexi District, Shenyang City as an example. Download map data according to OpenStreetMap, read the data using Elk and build community buildings and roads in Rhino. The BAKE function was used to display the map to a separate layer, create a person template based on the research information, select the starting point as the exit of each unit and the destination as the community gate, and set the points of interest as the shop, grass and seats in the community. Based on this data, PedSim was conducted. 300 people were randomly simulated in each of the four templates, and it was found that although there were many open spaces in the community. The crowd gathered in only four of them, especially in



(a) Grasshopper algorithm process (b) PedSim (c) Analysis of results

Fig. 5. Practical application of parametric pedestrian analysis

the middle area, where the crowd was most concentrated. Therefore, a preliminary site for the construction of a pocket park within this community can be determined (Fig. 5).

5 Conclusion

In summary, some of the site selection problems in pocket park design can be solved by Rhino parametric modeling. Regardless of the fact that the parametric modeling approach is not a complete replacement for site research, this approach saves time. This approach can also be helpful for siting problems in landscape and architectural design.

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