Modularization of Landscape Architecture Based on Computer Aided Design Involvement in Aesthetics

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Abstract. Since ancient times, there have been precedents of planting trees and flowers around siheyuan. Based on the intervention of aesthetics, the landscape modularity is combined with the residential landscape architecture examples in various places. Based on computer aided technology, this paper takes residential area as an example and expounds the different forms of plant landscape configuration in various buildings. Combined with computer aided technology, it can quickly and effectively extract the plant landscape module and apply it to the plant landscape design, providing reference for the plant landscape design of other residential buildings.

Keywords: Landscape Module, Landscape Configuration, Landscape Architecture, Involvement in Aesthetics, Computer Aided Design

1. Introduction
Since ancient times, there have been precedents of planting trees and flowers around the courtyards. For example, “Peaches in the east, willows and elm in the west”, “Jujube in the south, apricots in the north”, and “Osmanthus planted at doorsteps” etc. [1-2]. In the national conditions of contemporary China, the population density of big cities is relatively high. Creating garden-like residential areas has become the first environment where people can have closer contact with nature. It is also one of the daily living environments that people are gradually pursuing, as an essential part of the environment construction and plant configuration of the residential area is closely related to the daily life of the residents. Based on the involvement in aesthetics, this paper explores the forms of plant landscape configuration in the landscape architecture design and forms a plant landscape configuration module, which aims to provide a reference for other similar styles of residential area landscape design.

2. Definition of landscape modularization
Modularity refers to the use of standardization principles and scientific methods, through the analysis and research of a specific type of product or system, to separate the units containing the same or similar, unified, merged, simplified, and obtained independent existence in the form of universal units General module [3]. The landscape architecture module is mainly based on the hard landscape and is mainly based on the plant materials in the garden. It is extracted from the landscape design and can be applied to various assembly components in the landscape design for assembly [4]. The residential area

\[ \text{The formula goes here.} \]
is taken as an example, where different plant landscape modules are formed based on different forms of building households, which are mainly divided into high-rise residential areas and villa residential area building household modules. These plant landscape modules are extracted from the more beautiful plant landscapes. Into a plant landscape module, the corresponding plants are replaced accordingly. In the plant landscape design of residential buildings of the same style, direct references are used to achieve the purpose of rapid and efficient design.

The landscape design of the residential area refers to the rational use of trees, shrubs, vines, and herbs as the primary landscape material on the green area of the residential area. Combined with the gardening materials such as “water” and “terrain”, it follows the configuration principles reasonably to give full play to the natural beauty of plants, lines, colors and configure them into beautiful pictures that meet the aesthetic needs of people's involvement, making them rich in connotations with high aesthetic, ecological, cultural, social, and economic values. The living, dynamic landscape complex achieves the goal of involvement in aesthetics. The main configuration principles for the involvement in aesthetics are as follows: ① Combination of trees and irrigation, combination of evergreen plants and deciduous plants, fast-growing trees and slow-growing trees, appropriate configuration and decoration. The flower lawn simulates the complex community structure of arbors, shrubs, grasses, and groundcovers suitable for the area's nature, forming a plant landscape community with both aesthetic and biological characteristics. ② The choice of plant varieties should strive to be productive and diverse in a uniform tone. ③ Make full use of the ornamental features of plants, combine and coordinate colors, arrange plants according to the changes in colors displayed by the leaves, flowers, fruits, branches, and dried peels of the plants throughout the year to create seasonal landscapes. ④ Select native tree species and tree species with no apparent diseases and insect pests, and no apparent toxicity. At the same time, some new superior varieties can be appropriately cited to increase the landscape characteristics of the residential area. ⑤ Pay attention to the choice of planting location, so as not to affect the indoor lighting and ventilation and other facilities management and maintenance.

Participating aesthetic calculations are as follows:
If the posterior distribution function \( p(x_i|z_{0i}) \) of the state variables \( x_i \) of different known factors involved in aesthetics is known, then the mathematical expectation of any function is as shown in equation (1):

\[
E(g_i(x_i)) = \int g_i(x_i) p(x_i|z_{0i}) dx_i
\]

(1)

It can be approximated as equation (2):

\[
\overline{E}(g_i(x_i)) \approx \frac{1}{N} \sum_{i=1}^{N} g_i(x_i')
\]

(2)

The discrete sample \( \{x_i', i = 0, \cdots, N\} \) is a sample sequence sampled from the posterior distribution function \( f(x|z) \). When \( N \) is large enough, \( \overline{E}(g_i(x_i)) \) absolutely converges to \( E(g_i(x_i)) \). Hence, how to obtain the posterior distribution function becomes the key to solving the problem.

The core of the algorithm involvement in aesthetics is to use a set of the weighted sample set \( S = \{(x^*, \pi^*)| n = 1, \cdots, N\} \) to approximate the posterior distribution function \( f(x|z) \). Each sample point consists of two parts, \( f(x|z) \) represents the state of the target, \( \pi^* \) represents the probability of this sample, and \( \pi^* \) satisfies the condition \( \sum_{n=1}^{N} \pi^* = 1 \). Through the discrete sample set \( S \), the expected value of the target state can be obtained, as shown in equation (3):

\[
\sum_{n=1}^{N} \pi^* g_i(x^*)
\]
\[ E[S] = \sum_{n=1}^{N} s^n \pi^n \quad (3) \]

To configure different landscape architecture modules, suppose sample \( s = \{x, y, x', y', h\} \), where \( x, y \) represent the central position of the movement configuration, \( x', y' \) represent the scalars of various elements of the movement, and \( h \) represents the quantity to be configured. The configuration of the sample set is represented by the target, as shown in equation (4):
\[
s_i = As_{i-1} + w_{i-1} \quad (4)\]

3. Arrangement of household plants based on involvement in aesthetics

3.1. Arrangement of plant landscape in high-rise residential areas

The population density of high-rise residential areas is relatively high. It is necessary to comprehensively consider the common aesthetics of all residents. Plants around the building should consider the relationship between the north-south orientation and the position of the window. Tall trees should not be planted near the window. To ensure daylighting. The tall trees around the window should be selected with sparse branches and deciduous trees. The distance between the surrounding trees and the building should be greater than the height of the trees.

“Rose County” high-rise residential buildings in Chengdu (Figure 1) are featured by smooth straight-through, no steps, and wide roads. The landscape configuration mainly uses arbor (hackberry, Elaeocarpus decipiens, white orchid) + arbor irrigation (loquat, osmanthus) + shrub ball (camellia, sea tung ball, red following wood ball, heather ball) + shrub ground cover (sea tung, star anise Gold plate, red following wood, gold leaf false forsythia, coral hedge). In the landscape configuration, the hackberry tree and Du Ying form a skeleton tree, which is high in height, small in the middle layer, and low in the canopy to facilitate floor lighting. The level of sight in the lower layer is high, and the plant configuration is attractive.

![Figure 1. “Rose County” building household entry](image-url)

Ningbo “Shuian Fengqing” high-rise residential buildings are featured by a combination of steps and households with disabilities. The landscape configuration mainly uses arbor (Lechang smile) + arbor irrigation (myrica, osmanthus, golden locust, red maple) + shrub ball (Red Photinia, red following wood ball) + shrub ground (Mahogany, purple rhododendron, golden Ye Lizhen, etc.). In this plant configuration, the ground cover is decorated with fur balls. The bayberry planted on the periphery of the residual slope is suitable for shielding and beautification. Lechang Michelle is used as a skeleton tree with evergreen bayberry and osmanthus, deciduous tree golden locust and red. Maple and osmanthus both increase the amount of green and the fragrance. Osmanthus fragrans is suitable to be planted at the building's home. Golden locust and red maple ensure the richness of the landscape color and form a beautiful picture. The plant landscape module can be applied to the same style of
building households.

The residential buildings in the “Golden Coast” high-rise residential area in Hangzhou are featured by the surrounding water and many stones. The botanical landscape here is mainly palm plants (Washington palm, Canary date), with shrubs. Species (camellia, mimosa) and shrubs (red Jimu, Nantianzhu, Zizhu, etc.). The landscape configuration has a southern style. The palms of Washington are scattered high and low, and the space is abundant. The canary date is near the window, relatively low, which has enriched the lower landscape. There are massive green plants at the corner of the building, which softens the edges of the building and forms a beautiful plant landscape. The plant landscape module can be applied to the the surrounding water for the same style of households.

3.2. Plant landscape layout in the villa residential area
In the house planting configuration of the villa area, some bush balls with a small volume should be selected near the window. The position of the small shrub ball should be no less than 0.8m from the wall, and low-flower shrubs should be planted outside the doors and windows. Where large trees are planted on the outside of doors and windows, some sparse branches and deciduous trees are selected if possible. In addition, the distance between the tree and the building should not be less than the height of the tree (on the south side of the building), and the ratio of deciduous and evergreen trees should be controlled.

The residential buildings in the “Yutangshan” villa residential area in Beijing (Figure 2) have no courtyard, and the pedestrian entrance is connected with the garage entrance. The main plant applications are arbor (cedar, spruce, Magnolia magnolia, Yuanbaofoeng, Quercus mongolica, etc.) + arbor irrigation (elmberry, crape myrtle, lilac, cherry blossom, etc.) + shrub ball (forsythia, rose, Ligustrum lucidum) + shrub ground cover (Purple berberis, Euonymus japonicus, silver edge awn, iris, seasonal flower). It has a large group of green spaces. The cedar tree has increased the amount of greenery. At the same time, it is the boundary of the soft landscape of the villa courtyard. Mongolian oak and the clusteredacer truncatum contrast with each other. Form the focal point of sight, the plant landscape module can be applied to the home of the same style building.

Figure2. “Yutangshan” building household entry

Hangzhou Greentown “Taohuayuan” villa area has a clear boundary to the home courtyard. The main plants used include arbor (Pistacia chinensis) + arbor irrigation (Sophora japonica Golden Stem, Osmanthus fragrans) + shrub ball (camellia, Nandina domestica, knotwood, Admiralty, Cercis, Ternstroemia gymnanthera, Lorpetalum chinense var.rubruar) + shrub ground cover (Golden leaf privet, hypericum, hair cuckoo and flower border plant). Pistacia chinensis and Osmanthus fragrans create a plant space at this home. The lower plants are planted in a flower border style. The left and right sides of the house stand against each other but are not strictly symmetrical. The small trees near the home steps are full of plants, and colorful plants are planted. In the same style courtyard home,
using this plant landscape module, plants can be slightly replaced, for example, golden locust is used to replace red maple to construct different landscapes of the same style.

The “lakeside garden” villa area of Qiandao Lake in Hangzhou is a single-family villa with a clear boundary. The main application of plants at the home is arbor (Pak tree, Guohuai) + arbor (Washington palm, Jingui, bayberry, triangular maple, Lagerstroemia indica) + Shrub ball (Canary date, buddy coconut, cycad, gold leaf privet ball, woolen cuckoo ball, red following wood ball, etc.) + shrub ground cover (coral hedge, red fir tree, golden leaf privet, hair cuckoo, Rhododendron, etc.). This home uses palm plants and deciduous trees to form a space to set off the high-end atmospheric style. To create the privacy of the courtyard, hedges are used to fence the inner side of the wall and between the courtyard and the courtyard, and the outermost side of the ground cover plants is surrounded by a lawn, which, however should not be too narrow to facilitate later maintenance and management.

4. Conclusions
In the construction of plant landscapes of modern residential areas, plant landscape configuration is affected by multiple factors such as regional environment, cultural landscape, and construction cost, and the forms of plant landscapes are diverse. In this study, only some styles are set out in the plant landscape module. Where the basic principles of plant configuration are followed, the quick design of plant landscape complexes that meet the diverse needs of people as a plant landscape complex with natural, ecological and aesthetic characteristics can be implemented for sure.

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