Prediction model of spatial distribution pattern of building based on Neural Network

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Abstract. The traditional prediction model of building spatial distribution pattern change has the problem of poor prediction accuracy, so a prediction model of building spatial distribution pattern change based on neural network is designed. Based on the analysis of the spatial characteristics of traditional villages in Southeast Chongqing, this paper uses the neural network method to predict the change of the spatial distribution pattern of buildings, so as to complete the construction of the prediction model of the change of the spatial distribution pattern of buildings, and puts forward the planning and design strategies of traditional villages in Southeast Chongqing for the effective planning of traditional villages in Southeast Chongqing. The experimental results show that the prediction model based on neural network is more accurate than the traditional model, and can meet the needs of the prediction of the change of the spatial distribution pattern of buildings.

Keywords: Neural network;Architecture;Spatial distribution pattern;Change;Forecast;

1 Introduction

The spatial pattern of traditional villages reflects the formation and evolution of villages, as well as the allocation of natural and social resources. It is a concentrated reflection of its characteristics, which can directly and comprehensively reflect the historical evolution and value characteristics of the whole village. It is the focus of traditional village protection. However, in the protection process of traditional villages in Chongqing, there are not only a large number of problems, scattered distribution, remote region, backward development, but also the phenomenon of ethnic cultural differences, ineffective protection and management, which leads to the poor accuracy of the traditional prediction model of the change of the spatial distribution pattern of buildings. Therefore, it is necessary to predict the change of spatial distribution pattern of buildings in Chongqing. This study focuses on the southeast of Chongqing, which is located in the basin edge mountainous area where the two mountain systems of dalushan and Wuling Mountain meet in the southeast of Sichuan Basin, mainly including Qianjiang District, Shizhu, Pengshui, Youyang, Xiushan and "one district, five counties" of Wulong county. Southeast Chongqing, as one of the few minority gathering areas in the country, is the key area for China to implement the strategy of targeted poverty

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alleviation and relocation. Alpine ecological migration is an important measure to solve poverty and protect ecology in combination with the reality and influencing factors of poverty in Chongqing. In recent years, it is highly valued by the state and the government. However, with the rapid rise of rural construction and the policy support of poverty alleviation through relocation, ecological migration has made great achievements. At the same time, there are a series of problems. In order to pursue the scale effect of rapid rural construction, the spatial planning of new immigrant villages often applies the urbanization construction mode. This "homogenization" construction can not be applied to the new ethnic minority immigrants with regional cultural characteristics In villages, the blind application of model construction will only bring about a series of problems, such as spatial alienation, cultural fault, employment difficulties and psychological maladjustment caused by immigrants' loss of land survival skills after they are far away from their homes.

Literature [1] put forward the spatial distribution pattern and combination method of typical natural secondary forest species in Zhejiang Province. In this study, four 1-hm2 stands were established in coniferous and broad-leaved mixed forest and broad-leaved mixed forest, including two mixed forest (No.1 and No.2), two broad-leaved forest (No.3 and No.4). The distribution and relationship of dominant species in different life stages were studied, and the combination and distribution of species were detected 。 The species with DBH ≥ 5cm were identified. The density of Pinus massoniana in zone 1 was lower than that in zone 2. In this study, the spatial distribution of dominant tree species and communities of different tree species were analyzed by spatial point model analysis. However, the prediction accuracy of this method is low.

In view of the problems of the above methods, this paper starts from the analysis of the spatial characteristics of traditional villages in Southeast Chongqing, designs a prediction model based on neural network for the change of building spatial distribution pattern, and puts forward the planning and design strategies of traditional villages in Southeast Chongqing according to the existing problems, so as to complete the prediction of building spatial pattern change based on neural network.

Among them, neural network is an algorithm mathematical model that imitates the behavior characteristics of animal neural network and carries out distributed parallel information processing. This kind of network relies on the complexity of the system, through adjusting the relationship between a large number of internal nodes, so as to achieve the purpose of processing information.

2 Prediction model of spatial distribution pattern of building based on Neural Network

2.1 Spatial characteristics of traditional villages in Southeast Chongqing

The settlement space of Tujia Nationality in Southeast Chongqing is affected by natural environment, clan system, livelihood and other aspects. According to the distribution of terrain and geographical environment, it is mainly divided into mountain village settlement and town settlement, which correspond to clan settlement and trade settlement respectively. Clan settlement is called a community formed by farming together in the same family unit, an autonomous group with common living habits and certain rules and regulations, a self-sufficient natural economy within the clan, a closed and autonomous group social organization established in strict accordance with traditional standards, from the whole clan's life organization to spiritual organization and social organization, the patriarchal system is firmly printed Color. The spatial form of clan settlement is hierarchical, and different levels of public space will appear in the level of social attribute [2]. The higher the level, the more popular the places gather, and the larger the activity space correspondingly. Although the hierarchy will be accompanied by the central spatial form, the Tujia settlements in Southeast Chongqing are not central due to the limited mountain conditions, and most of them are distributed in a decentralized layout, closed and stable.

Most of the clan settlements are staggered with Han and Miao villages. Most of the villages are built on the hillside near the mountain and the water. This is because the plain dam in Wuling mountain area is very precious and there are many mountains and few land, so most of the flat land is left for farming. As shown in the figure below:

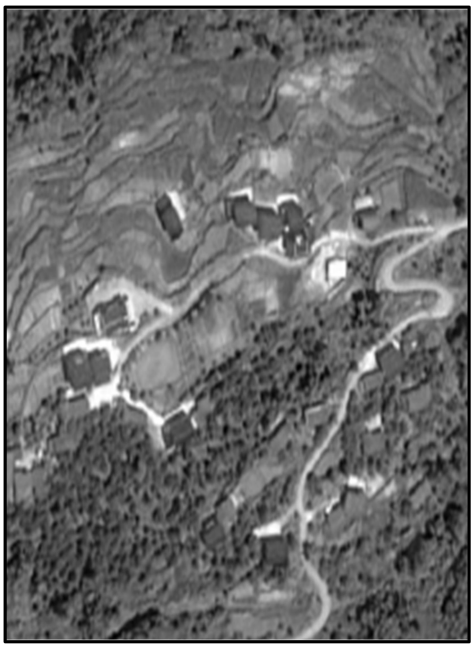


Fig. 1. Settlement distribution map

Most of the clan rural settlements are the combination of mountain buildings and alleys according to local conditions. Their development form is to form buildings first, and then to form streets and alleys. The whole growth process is based on nature and integrated into nature, so on the whole, the form presents an occasional interest. This is because the clan settlement is affected by the terrain and environment, and less restricted by the etiquette system. The stacked Tujia courtyard appears random and flexible in space. One of these two forms of settlements is called "market", which is an open-air trading and trading mode that specifies a certain area at a certain time node; the other is that on the flat dam, a single house gradually develops into a market. Such trade settlements generally have water systems passing through, and the houses expand along the street. The general layout of Tujia traditional town settlements in Southeast Chongqing is mainly in linear form. Due to the local topography and residents' sense of settlement, such settlement area will not be too large and will not continue to expand. If the buildings that violate the rules and the streets and lanes are regarded as positive and negative spaces respectively, the buildings that form the relationship between the front and back of the streets and lanes are negative spaces, and the streets that are full of twists and turns are positive spaces. If they are extracted in the form of the relationship at the bottom of the figure, they will show the form of natural beauty, as shown in the following figure:

(a) Aerial view of a place in Southeast Chongqing

(b) Old street alley mechanism

Fig. 2. Spatial characteristics of some traditional villages in Southeast Chongqing

2.2 Construction of prediction model for the change of spatial distribution pattern of buildings

From the perspective of public space, the sun dam space of traditional courtyard carries the function of activity, but the model rural construction loses the public space of communication, as shown in the following figure:

Fig. 3. New rural planning destroys the original spatial pattern

In the practical work of predicting the change of spatial distribution pattern of buildings, the multi model combination with mutual error correction function should be a means to obtain the ideal spatial analysis effect. The prediction process of building spatial distribution pattern change is shown in the following figure:

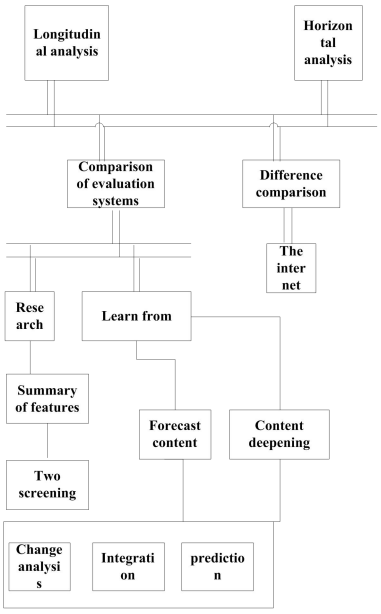


Fig. 4. Forecast content selection process

In the study of evolution of urban residential spatial distribution pattern, neural network method is used to predict the change of architectural spatial distribution pattern, and the linear distance between the regional center point and the residential space center point is solved by demand [4]. If the coordinate of demand point is (x, y) and the coordinate of residential space center is (k, l), the algorithm steps are as follows:

Step 1: randomly assign m living space;

Step 2: according to the principle of the nearest distance, find out the ownership relationship between the residential space and the demand point [5], expressed by binary variable a_{ik}, and find out the total distance;

Step 3: compare the total distance calculated this time with the total distance calculated last time. If the difference between the two values is less than the error limit [6], stop the calculation. The calculation process is as follows:

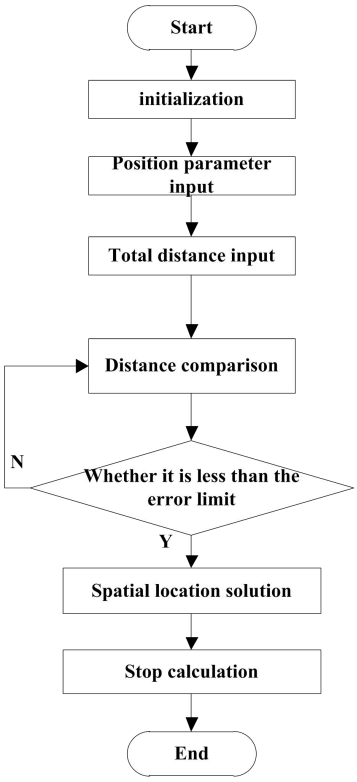


Fig. 5. Calculation process of total building distance

Step 4: according to the following formula, solve the location of each living space in the next step to study the overall trend and difference of spatial correlation of observation variables in the whole study area, and the formula is as follows:

$$I = \frac{s}{n} \cdot \frac{t\left(x_i - x''\right)}{\sum_i o} \quad (1)$$

In formula (1), n is the number of spatial units in the study area, t is the observation time, x_i and x'' are the observed values of architectural spatial units, $\sum_i o$ is the spatial weight matrix, and s is the sum of spatial weight matrix.

Step 5: on this basis, reveal the heterogeneity between the attributes of different spatial units in the study area [7], and the calculation formula is:

$$I = z_i \sum_n o / g \quad (2)$$

In formula (2), $z_i \sum_n o$ represents the standardized value of the observed value of the spatial element, and g is the spatial weight.

Step six: neural network is used to analyze the concentration degree of observation values in local space, which can further measure the spatial distribution of hot spots and cold spots

$$G(o) = \frac{j|l|}{\sum_i q / x} \quad (3)$$

In formula (3), $\sum_i q / x$ represents the space distribution calculation parameters of hot spot area and cold spot area, and $j|l|$ represents the original value of building space distribution.

According to the above process, the change prediction of building spatial distribution pattern [8] is completed, and the whole prediction model is shown in the following figure:

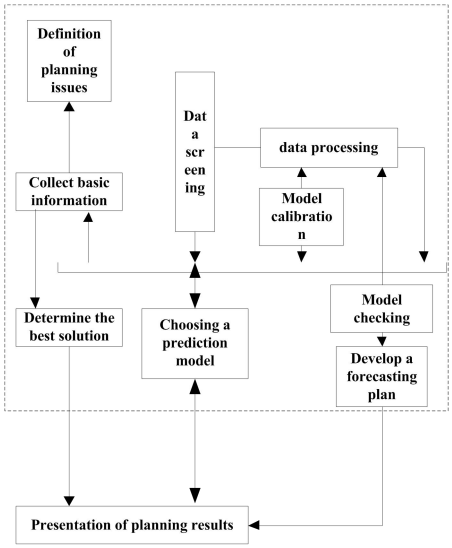
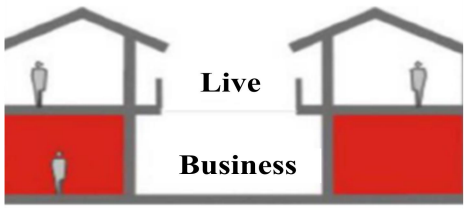


Fig. 6. Prediction model of spatial distribution pattern of buildings

3 Planning and design strategy of traditional villages in Southeast Chongqing

On the basis of the above prediction of the spatial distribution pattern of buildings, in order to effectively plan the traditional villages in Southeast Chongqing, the planning and design strategies of the traditional villages in Southeast Chongqing are put forward. The characteristics of the southeast mountainous area of Chongqing make Tujia people have deep special feelings for the mountain. They advocate nature and think that the mountain is the spiritual existence in their mind. The mountain not only provides them with material means of production, but also the sustenance of their spiritual belief. Therefore, the planning of Tujia NEW village should respect the nature and develop spatial layout according to the mountain situation. The layout of commercial and residential mixed functions is shown in Figure 7:



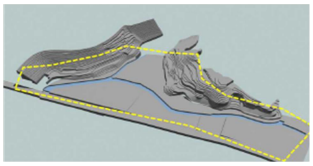
(a) Before transformation

(b) Before transformation

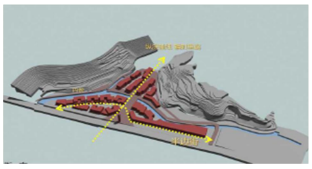
Fig. 7. Commercial and residential mixed function layout

In order to adapt to Tujia's deep feelings for mountains and create a familiar living space, the project divides the site into half slope area, central flat dam area and along block area according to the terrain characteristics, and launches different building combination layout for different terrain areas. First of all, along the hillside of Banpo District, the qiqikou setback building is arranged, and the setback courtyard group has a good view line and ecological environment; secondly, the central Pingba district is arranged with a combination of courtyard manual workshop group [9], which is a courtyard street space composed of a unit mode; there are also the commercial building group near the street, which uses the compound architecture It encloses a linear commercial street and market space. Through the building layout mode that matches the mountainous terrain, the rich and changeable building forms and levels are formed, and the Tujia mountain villages with aesthetic and regional characteristics are created, which is conducive to the combination of rural tourism and new rural areas, on the basis of building a beautiful village environment, improving the income of farmers, transforming living conditions, and thus the rural construction goal of "beauty in the farmhouse" is achieved. According to the needs of different types of houses, three kinds of single building modules are formed in the planning, and the single group Village growing spatial pattern is adopted. The settlement pattern of Tujia traditional towns is flexible and changeable. The growing spatial texture is concave and convex, beautiful and conducive to creating a variety of living spaces. In order to restore the noumenon characteristics of Tujia villages and avoid "barracks style" The destruction of the traditional rural space by the urban pattern, this spatial planning is carried out on the basis of adjusting measures to local conditions, using the spatial design pattern of "single group Village" to continue the traditional growing texture. This method refers to the basic unit of Tujia residential "room" and the composition mode of unit assembly yard. This mode determines the building unit module according to the needs of different house types, and forms a dense, flexible and changeable village as a whole through a certain regular

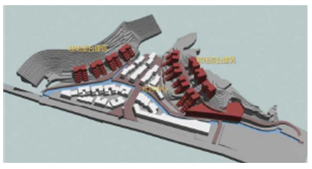
combination of collages. The spatial mode of "single group Village" starts from the basic unit, and considers the integration of building base boundary and courtyard. According to the needs of housing type in the resettlement area, two or four basic units of different forms are determined, and then the unit evolves into a large group with spatial changes. The orderly growth of the group can develop into a continuous and changeable village space, which can be based on different items The purpose of this paper is to develop the spatial layout flexibly and to be operable. The growing spatial texture of "single group courtyard" is a continuation of the traditional Tujia village form and a certain logical village spatial growth mode, which is of reference significance to the new village spatial planning. This kind of space technique is helpful to build a living place with traditional urban intention and living atmosphere, and bring the traditional rural aesthetic feeling and comfortable street dimension to the new village residents to become a harmonious and beautiful living space, so as to achieve the design goal of "the beauty of farmhouse". The planning scheme of traditional villages in Southeast Chongqing is as follows:



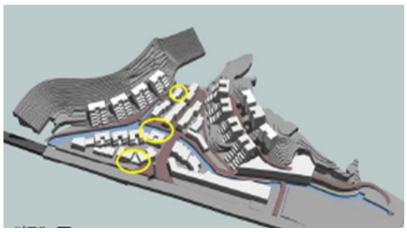
(a) Use of triangular fan-shaped space



(b) Street + City Hematopoietic Space



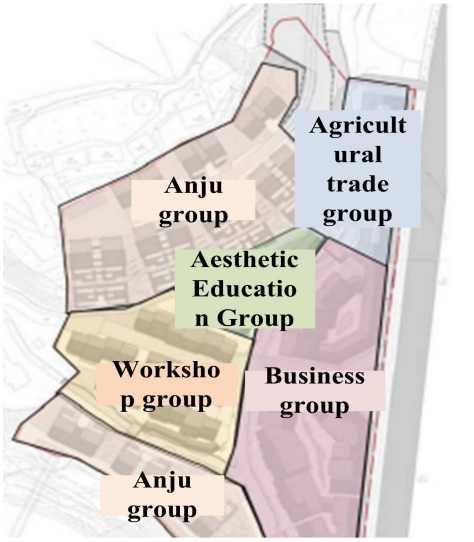
(c) Mountain + Mountain Home



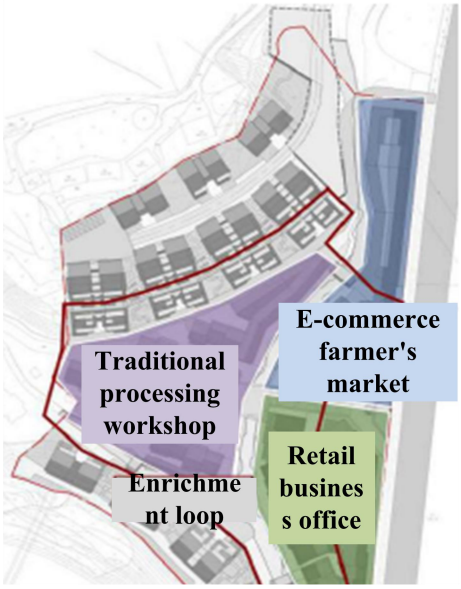
(d) The dam

Fig. 8. Planning scheme of traditional villages in Southeast Chongqing

Reasonable functional layout can optimize industrial structure, effectively promote the development of industry and efficient use of space. Due to the severe employment test faced by ecological migrants, how to use space to create employment needs to be considered from the perspective of space function. Most of the resettlement areas lack of effective use of space, so it is difficult to meet the basic needs of the way of life and production of migrants. In order to achieve the design goal of "rich in rural areas" and realize the needs of residents' employment in the land through the study of spatial functions, the following are the specific design methods of functional spatial layout, mainly including the composite functional mode and functional space placement, as shown in the following figure:



(a) Project Space Streamline



(b) Functional group layout

Fig. 9. Boundary reorganization of functional groups

The above figure shows the boundary reorganization process of the building function group. The farmer's market is located in the north of the commercial market. It is dominated by the e-commerce farmer's market, which can not only provide the place for farmers' trade, but also provide the employment space for the industrial transformation. The farmer's market can meet the purchase needs of residents' daily life. The e-commerce market realizes the local employment of some residents through the industrial transformation. As lijiaxi project is located in Qianjiang high tech Industrial Park, the surrounding area has the development advantages of Internet industry. Immigrants can take advantage of the industrial transformation and improve their skills and employment ability. The government can vigorously develop the Internet of things industry by virtue of the industrial advantages, establish and improve the circulation network, use the Internet, the Internet of things and other traditional industries to upgrade, and help migrant residents expand employment and participate in innovation Industry and so on. In terms of spatial planning, the large skylight shed formed by building enclosure can become the agricultural trade market, and the Internet of things industry can be distributed in the commercial buildings on the street according to the spatial advantages. In this way, the mixed industry model will also make full use of the space, and combine the agricultural trade market and the e-commerce space. The mixed industry model is a space with dual effects, and effectively realize the transformation and prosperity of

immigrants The design goal of the rich in the farm. So as to complete the planning and design of traditional villages in Southeast Chongqing.

4 Experimental comparison

In order to verify the validity of the prediction model based on neural network, the experimental comparison is made. In order to ensure the preciseness of the experiment, the designed model is compared with the traditional model, and the prediction accuracy of the two models is compared.

The building data of a certain place from 2011 to 2012 is taken as the experimental object, and the basic experimental data are shown in the table below:

Table 1 experimental data

Serial number	sub option	Details
1	Village environment	Mountains and rivers，geology and geomorphology
2	Traditional village pattern	Village ，pattern mechanism，important public space
3	traditional building	Area，function，use situation
4	Historical environment	Production，fire protection，defense
5	Intangible Cultural	Production lifestyle

Take the above data as the experimental objects of the two models.

4.1 Experimental platform

NS2 is used to design the experimental platform, as shown in the figure below:

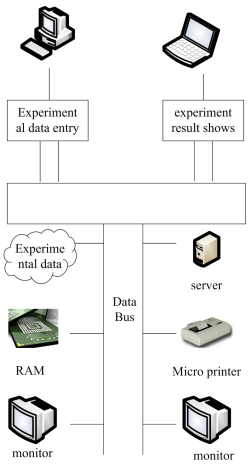


Fig. 10. Experimental platform

The experimental data are recorded and the corresponding experimental results are output.

4.2 Analysis of experimental results

The comparison results of prediction accuracy between the traditional model and the designed prediction model based on neural network are shown in the following figure:

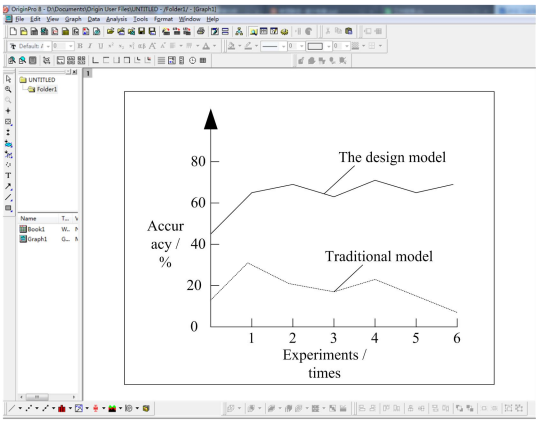


Fig. 11. Experimental comparison results

Analysis of the above comparison results shows that the prediction accuracy of the designed model is higher than that of the traditional model, and the prediction accuracy of the traditional model is gradually declining. However, the overall prediction accuracy of the design model is high and the prediction is relatively stable, which can prove the validity of the design model based on neural network.

5 Concluding remarks

In this paper, a prediction model of building spatial distribution pattern change based on neural network is designed, and the validity of this design model is verified by experiments. However, there are still some deficiencies in the design model, which is limited in the research scope and depth of typical buildings, and can not fully cover all the traditional villages in Chongqing area, and the village research can not be fully in-depth, so it may cause the loss and deviation of village value indicators. These insufficient factors are the direction for further research in the future. In the future research, with the enrichment of data and in-depth research, it is hoped that the prediction model of building spatial distribution pattern change will be gradually improved, which will provide reference for the prediction of building spatial distribution pattern change in the whole southwest region and even the whole country.

6 Fund projects

Chongqing Municipal Education Commission Science and Technology Research Project: Spatial Features and Planning of Traditional Villages in Southeast Chongqing
Research on design strategy (KJQN201904301).

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