



Simulation Study on Pedestrian Road Planning in Ancient Building Groups Under Cloud Computing Environment

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Abstract. In order to guide the traffic organization in the ancient building group in an orderly manner, the simulation study on the pedestrian road planning of the ancient building group in the cloud computing environment is proposed. Based on the analysis of the characteristics of pedestrian roads, a cloud computing environment road planning simulation model is established. Using the cloud computing environment to determine the maximum number of people on the road, use the simulation software LEGION to set the structure and parameters of the model, and carry out road planning and deduction in the simulator to realize the design of the road planning simulation model. Through the method of experimental argumentation and analysis, the effectiveness of the cloud computing environment road planning simulation model is determined, which can improve the order planning of pedestrians' road planning.

Keywords: Cloud computing environment · Ancient building complex area · Road planning · Simulation model

1 Introduction

With the vigorous development of China's tourism industry, the area of ancient buildings and antique buildings has been favoured by more and more tourists, and has become a hot development area for China's tourism industry [1]. The buildings are closely connected, the roads are narrow and the steps are all over. Due to the limitations of many limitations, in the event of a dangerous accident, the traffic organization in the ancient building complex area is difficult to obtain effective control. It in turn led to traffic congestion in the ancient building complex area, and even caused casualties such as trampling.

Cloud computing is a model of the addition, use, and delivery of Internet-based related services, often involving the provision of dynamically scalable and often virtualized resources over the Internet. In the past, the cloud was used to represent the

telecommunication network, and later used to represent the abstraction of the Internet and the underlying infrastructure. Therefore, in the cloud computing environment, you can even experience 10 trillion operations per second, and have strong computing power, which can simulate the trend of nuclear explosion, forecasting climate change and market development [2]. Literature [3] proposed the pedestrian road friendliness evaluation based on attribute measure. By constructing the index system of pedestrian environmental friendliness evaluation, the optimal planning of pedestrian road is realized by classifying the road planning samples with the principle of attribute measure. But the planning effect of this method is not ideal. Therefore, how to apply the cloud computing environment to the pedestrian road planning and simulation in the ancient building group in an optimal way has become a new direction for scholars.

This paper proposes a simulation study of pedestrian road planning in ancient buildings based on cloud computing environment. The results show that the road planning simulation model based on cloud computing environment can effectively guide the pedestrian traffic in the ancient building complex area, ensuring smooth pedestrian traffic and high efficiency.

2 Analysis of Pedestrian Traffic Characteristics

In the current pedestrian traffic environment in the ancient building complex area, the situation of pedestrians crossing the street is relatively poor, and has not yet become the focus of relevant laws and regulations and traffic management policies [3]. Assuming that the intervening gap of the pedestrian road is S_k and the speed of the incoming vehicle is X_k , the function expression of pedestrian traffic is:

$$X'_{ik} = \frac{X_{ik} - X_k}{S_k} \quad (1)$$

Where X'_{ik} represents the pedestrian pass probability; X_{ik} represents the walking gap of the pedestrian, and X_k is a constant, usually $X_{ik} = \{1 + i, 2 + i, 3 + i, \dots, k + i\}$.

In addition, the individual differences of pedestrians are also the main factors affecting the changes of pedestrians' road characteristics, including the gender, age, personality, education level, group relationship, and cognitive level of pedestrians [4].

At the same time, the number of tourists in the scenic spot, the passage of the road, and the capacity of the ancient building complex area [5] are also the most important factors affecting the sharp increase in the characteristics of pedestrians. The factors influencing the capacity of the ancient buildings are the narrow tortuosity of the ancient buildings, the number of steps, the obstruction of the pedestrian's visual field, and the judgment of the road ahead. They all have a significant impact on the pedestrian road characteristics.

3 Establishment of Cloud Computing Environment Road Planning Simulation Model

Simulate the most complex scenic spots of pedestrian crossings in the ancient building complex area, located in the middle of the model. In addition, considering the characteristics of tourist traffic, terrain, steps, roads, etc., the optimal planning path of the model is judged [6]. The cloud computing environment road planning simulation model structure is shown in Fig. 1.

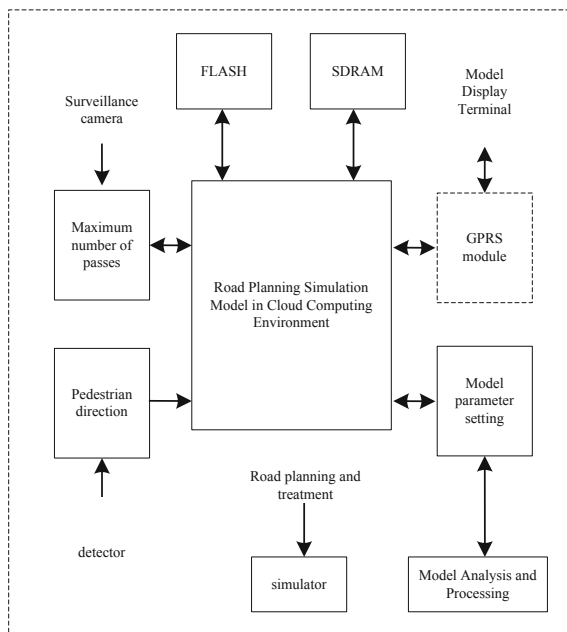


Fig. 1. Cloud computing environment road planning simulation model structure

3.1 Determine the Maximum Number of People

According to the principle of human flow density [7], the number of predicted pedestrians in the ancient building group area is determined. Combined with the functional expression [8] of the characteristics of pedestrian traffic, the maximum pedestrian density value of the pedestrian road in the ancient building group area is calculated. Among them, the pedestrian passing road feature X'_{ik} is set to a fixed value of $12 m^2/R$, and the maximum number of pedestrians passing through the ancient building group area is shown in Table 1.

Table 1. Maximum number of passengers

Fork setting	Pedestrian area/ m^2	Admissible population density/person $\cdot (m^2)^{-1}$	Maximum number of passes
Fork road 1	755	4.1	3009
Fork road 2	552	6.3	25980
Fork road 3	1135	2.5	3655
Fork road 4	281	2.7	5869
Fork road 5	281	5.9	15265
Fork road 6	569	2.1	1425
Fork road 7	785	4.5	6557

After calculating the maximum number of pedestrians in the ancient building group area, the results are summarized by *CAD*, and the *CAD* drawing is simplified and imported into the simulation software for verification. According to the characteristics of the steps and buildings of the ancient building group, referring to the maximum number of passengers, the maximum number of people in the ancient building group is obtained:

- (1) Due to the dense population of pedestrians in the ancient buildings, the high-speed operation of the vehicle not only leads to frequent disconnection of the wireless communication link between the vehicles and between the vehicle and the roadside unit [9], but also cannot form a stable topology, so the maximum number of passengers will be reduced.
- (2) Because the pedestrian's walking trajectory is limited, the position, direction and speed of the vehicle are predictable when walking along the pedestrian road. Therefore, the pedestrian can judge the road route to continue walking according to the driving motivation of the vehicle.
- (3) The ability of the pedestrian to judge is not limited, so the walking path can be freely selected according to the characteristics of the vehicle itself and the constant replenishment of energy.
- (4) Set up a global positioning system in the area of ancient buildings to accurately locate the boundaries and extension standards of roads. Under the premise of satisfying the characteristics of the maximum number of passengers, the pedestrians are provided with relevant information such as the speed and position of the vehicles, thereby ensuring the maximum number of pedestrians in the pedestrian passages in the ancient building group area.

After determining the maximum number of people in the ancient building group area, the rationality of the maximum number of people is guaranteed, and data preparation is provided for the parameter setting of the next pedestrian road planning simulation model.

3.2 Road Planning Simulation Model Parameter Setting

Pedestrian road planning modeling using traffic simulation software LEGION [10]. In this paper, the intersections in the road network are regarded as one node, each road is regarded as the connection between two nodes, and the whole road network is abstracted into a directed network diagram composed of points and connections. Therefore, this paper adopts the adjacency matrix to express the relationship between each node in the entire road network and each node and the connection. The traffic path in each pedestrian network in this paper stores two parameters, namely speed parameter and weight parameter.

The speed parameter stores the time of the average pedestrian travel speed information of the road segments existing in the entire road network [11]. Before the pedestrian enters the road network, the speed parameter needs to be initialized, and the maximum speed allowed by the given road segment is given. The unconnected road in the road network is given an initial speed of zero. After the pedestrian enters the road network, it receives the information transmitted by other pedestrians in the road network, and updates the real-time information to its own speed parameter according to the comparison time stamp. The pedestrian speed parameter matrix is as follows:

$$\tau = \begin{bmatrix} \sigma_1^2 & 5 & 4 & 3 & 2 & 1 & 0 \\ X_{1ik} & \sigma_1^2 & & & & x_1 & \\ & X_{2ik} & \dots & & & & \\ & & X_{3ik} & \sigma_3^2 & & & \\ & & & X_{4ik} & \sigma_3^2 & & \\ & x_1 & & & X_{5ik} & \sigma_a^2 & \\ 0 & 1 & 2 & 3 & 4 & X_{6ik} & \sigma_a^2 \end{bmatrix} \quad (2)$$

Where τ represents the speed parameter of the pedestrian; $X_{1ik} \sim X_{6ik}$ represent the walking gap of the pedestrian; $\sigma_1^2 \sim \sigma_a^2$ represent the road bearing matrix during pedestrian travel; x_1 represents the average displacement of the pedestrian walking; wherein 0 to 5 are constant parameters.

The weight parameter is the weight of the road segment that exists in the entire road network. In this paper, due to the cloud computing environment [12], the weight value is affected by factors such as the length of the road segment, the congestion degree of the road segment and the maximum number of people on the road segment. Therefore, the weight parameter changes due to the change of the speed parameter. The weight parameter matrix of the road is as follows:

$$T_x = (A^T/Y^{-1})^{-2} = \left\{ \begin{matrix} X_{11}, X_{1n} \in A^T \\ X_{n1}, X_{nn} \in Y \end{matrix} \right\} T_x = (A^T/Y^{-1})^{-2} = \left\{ \begin{matrix} X_{11}, X_{1n} \in A^T \\ X_{n1}, X_{nn} \in Y \end{matrix} \right\} \quad (3)$$

Where T_x represents the weight parameter of the road; A^T represents the weight change in time T ; Y^{-1} represents the weight feature of the control center; X_{11} represents the pedestrian pass value; X_{1n} represents the communication weight; X_{n1} represents the road node weight; X_{nn} represents the weight of all road nodes.

The speed and weight parameters provide an intuitive way to collect road planning data and ensure that the most up-to-date data information is always stored for each location, preparing for the simulation of the road plan.

3.3 Road Planning Simulation Model Implementation

Apply the speed parameters and weight parameters of the road planning simulation model to the model realization process, and select SUMO as the traffic system simulation software SUMO C Simulation of Urban Mobility [13]. It is used as a time-discrete, spatially continuous pedestrian road planning system simulator. The implementation process is as follows:

Cloud computing environment road planning simulation model The topological relationship between roads is represented by virtual road segments within the virtual node. The virtual road segment contains the distance damping information such as distance damping information and signal time damping information when crossing the intersection, and the matrix relationship is as follows:

$$V = \sum_w^B \frac{1}{n} \quad (4)$$

Where V represents the matrix relationship between the segments; n represents the virtual segment information.

Set the road segment numbers to 30 roads, 305 roads, 408 roads, and 503 roads. By analyzing the road segments, vertices and polylines of the virtual nodes, the topological relationship between the nodes and the termination nodes is judged, and the spatial coordinates of the road planning simulation model of the cloud computing environment are established.

According to the cloud computing environment road planning simulation model, the detailed description of the actual traffic environment is different, and it is divided into microscopic simulation, mesoscopic simulation and macroscopic simulation. These three simulation techniques are applied to the model implementation process to track the planning of 30 roads, 305 roads, 408 roads, and 503 roads.

First, the static road network data information is read, including the distance between each node in the road network, the maximum traffic speed information allowed by the road segment, and the traffic congestion fee charge of the road segment, and the initial weight is calculated comprehensively. Then, based on the calculated initial weight, the weight of the road network is calculated again using a dynamic path planning algorithm based on the travel cost. Then when the vehicle continuously receives the speed information, the weight of the road network is recalculated. Repeat the above steps until the vehicle reaches the destination node, that is, the planning process for the pedestrian road is completed.

The cloud computing environment road planning simulation model is used to carry out the planning and deduction of pedestrian roads in the ancient building group area in the simulator to ensure the feasibility and effectiveness of the cloud computing environment road planning simulation model designed in this paper. So far, the road model simulation model design for the cloud computing environment is completed.

4 Simulation Experiment Demonstration and Analysis

In order to ensure the effectiveness of the road planning simulation model of the cloud computing environment designed in this paper, the simulation experiment demonstration analysis is carried out.

The experimental process is carried out in the traffic simulation software *LEGION*. The experimental object is set as a pedestrian road in an ancient building group, and the simulation and demonstration experiments are carried out. During the experiment, the arrangement of pedestrians in an ancient building group is shown in Fig. 2.

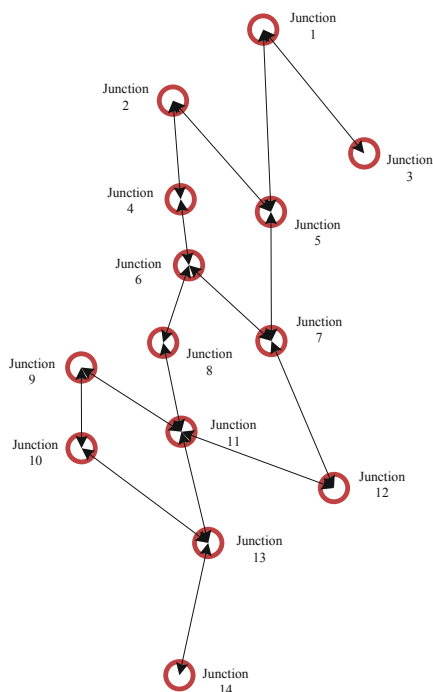


Fig. 2. Pedestrian road arrangement

In order to ensure the effectiveness of the experiment, the traditional road planning simulation model and the cloud computing environment road planning simulation model are used for comparison experiments, and the road planning quality of the two models is statistically calculated. Since the quality of road planning is not statistical, the road planning congestion rate is used as a measure of planning quality. The higher the road planning congestion rate, the lower the road planning quality; Conversely, the lower the road planning congestion rate, the higher the road planning quality. The experimental results are shown in Fig. 3.

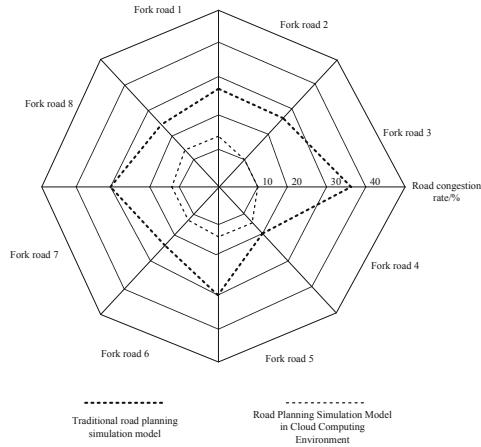


Fig. 3. Comparison of experimental argumentation results

According to the analysis of Fig. 3, the cloud computing environment road planning simulation model has a road planning congestion rate of less than 20% when planning the pedestrian roads in the ancient building group. However, the road planning crowding rate of the traditional road planning simulation model is about 40%, so we can see the advantages of the cloud computing environment road planning simulation model designed in this paper to improve the quality of road planning. When the cloud computing environment road planning simulation model is used for road planning, the planning is stable, and the location of the intersection Sect. 3 is consistent with the standard road planning model. The advantages of the cloud computing environment road planning simulation model designed in this paper can be seen more.

5 Conclusion

This paper studies and designs the pedestrian road planning simulation of the ancient buildings in the cloud computing environment, and analyzes the characteristics of the pedestrian roads in the ancient buildings based on the advantages of the cloud computing environment. On this basis, the simulation model of the pedestrian road planning for cloud computing environment is constructed. First determine the maximum number of people on the road, and then elaborate on the structure and parameter settings of the model. Finally, the cloud computing environment descendant road planning simulation model is simulated in the simulator to realize the design of this paper. The experimental results show that the cloud computing environment designed for pedestrian downlink road planning simulation model is extremely effective. When planning the pedestrian roads in the ancient buildings, it can greatly improve the planning quality of pedestrians, and can effectively reduce the simulation errors of road planning, save planning time, and improve the tourism economic benefits of ancient

buildings. It is hoped that the research in this paper can provide theoretical basis and reference for the planning and design of pedestrian roads in China's ancient buildings.

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