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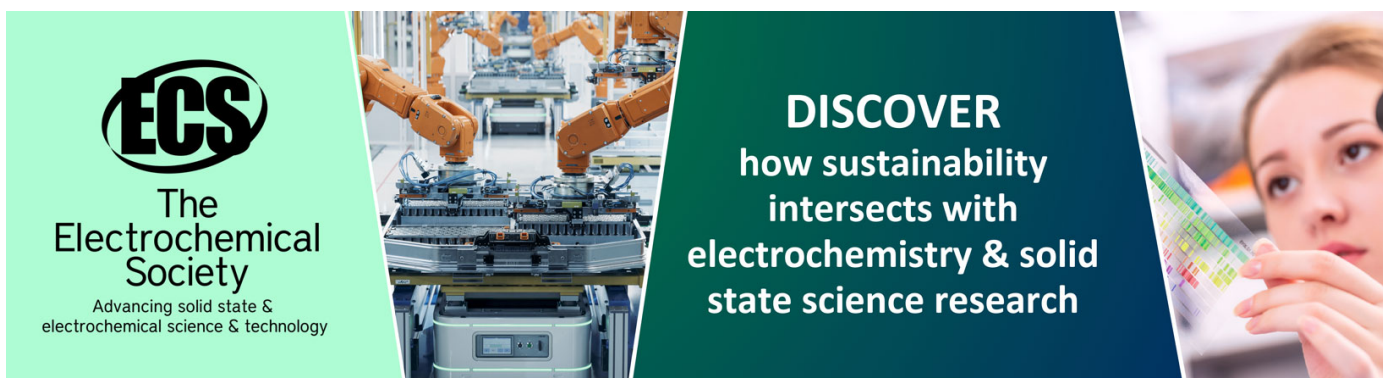
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Research on the construction of spatial-temporal network of multi-attraction smart scenic area based on information technologies

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Abstract. Information technologies such as mobile Internet, big data, artificial intelligence and remote sensing technology are playing an important role in smart scenic area. This study firstly defines the concept of multi-attraction smart scenic area. Secondly, we describe the construction about spatial-temporal network of multi-attraction smart scenic area, which helps to promote the tourists into orderly movement in multi-attraction smart scenic area and relieve congestion phenomenon of multi-attraction smart scenic area.

1. Introduction

Since the "smart tourism year" is proposed by the national tourism administration, the tourism industry has developed vigorously and smart tourism has become a new travel mode. Mobile Internet, big data, artificial intelligence, remote sensing and other technologies are playing a more and more important role in construction of smart scenic area. With these technologies, the tourists forecast of scenic area, passenger flow management and the experience of tourism become better in smart scenic area. Smart scenic area can make advance prediction and provide real-time guidance through online reservation and divert tourists offline, and use intelligent means to ease the flow of tourists.

In fact, the tourist management of most traditional domestic scenic areas is still mainly based on historical experience and simple emergency policy management by administrative means from the perspective of qualitative analysis. Especially when the individual scenic spots are crowded and the waiting time of tourists is long in the peak period, the tourist experience is reduced and the ecological environment of scenic spots is damaged. How to solve the problem of overload and congestion in the scenic area during tourism peak periods by spatial-temporal flow distribution of scenic area has become a research hotspot [1,2,3]. However, study on the construction process of the spatial-temporal network of smart scenic area with multiple scenic spots is deficient, which helps to promote the tourists into orderly movement in multi-attraction smart scenic area and relieve congestion phenomenon of multi-attraction smart scenic area.

Through information technologies such as Mobile Internet, big data, artificial intelligence and remote sensing, we can obtain much relevant information of tourists timely in smart scenic area, realize the transformation of tourism industry from traditional passive and post-event management to



process management and real-time management, and realize scientific decision-making and management.

2. The construction of spatial-temporal network of multi-attraction smart scenic area

2.1. Multi-attraction smart scenic area

There is no clear definition in domestic and foreign literatures for the concept of multi-attraction smart scenic area. Zheng weimin defined multi-attraction scenic area for the first time in his doctoral thesis, and analyzed the characteristics of multi-attraction scenic area [4]. On the basis of this research, the concept of multi-attraction scenic area will be further elaborated in this paper. Multi-attraction scenic area is defined as an advanced information technology integrated management scenic area which contains multiple scenic spots that can attract tourists or provide services and each scenic spot can be connected with each other by walking, cycling, self-driving or internal transportation.

2.2. Spatial-temporal network of smart scenic area

The characteristics of spatial-temporal network of scenic area first are shown in its temporal and spatial characteristics. The theory of spatial-temporal flow distribution proposed by Professor Ren Peiyu's team, that is, according to the principle of relative static space and dynamic time, the continuous rolling of time is being used to form "vacant" space for scheduling, decision-making and diversion of tourist distribution. And the spatial-temporal characteristics of the scenic area spatial-temporal network is the basis of reasonable spatial-temporal flow distribution.

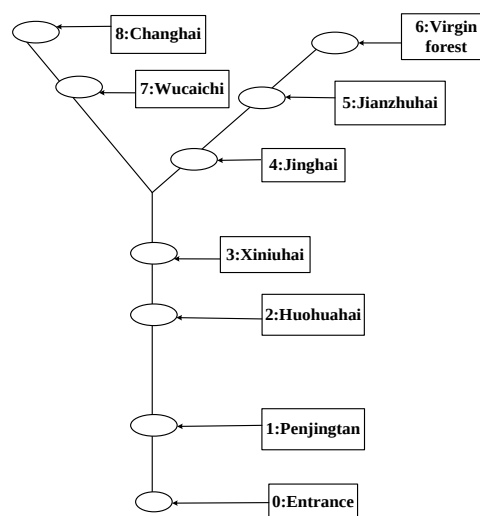


Figure 1. The distribution of main scenic spots in the scenic area of Jiuzhai Valley.

The concept of spatial-temporal network mainly focuses on the traffic network design [5,6]. Recently, spatial-temporal network has been gradually applied to other fields with the continuous development of related researches, such as spatial-temporal network of scenic areas. For a long time, due to the difficulty in obtaining tourist information and ambiguous about the rules of tourists' travel in the scenic area, the scenic area managers have been carrying out extensive management and post-dispatch, which has caused serious damage to the scenic area and greatly reduced the satisfaction of tourists. With the construction of smart scenic area, it becomes possible to obtain real-time tourist information in the scenic area and spatial-temporal network can also be well applied to the scenic area management. In addition, the tour process of tourists in scenic area can be devised into a complex spatial-temporal network.

The scenic spots in scenic area, trestle roads along cliff and roads connecting the scenic spots constitute a complex network. The distribution ratio of the network will change with the season, the

scale of tourists and the moment, making the changes of the load in the scenic area show chaotic characteristics. The traditional static network topology model can no longer represent the time-varying topology structure of scenic area. However, spatial-temporal network has great advantages in this respect. We will take Jiuzhai Valley scenic area as an example to describe the establishment process of spatial-temporal network of scenic area in detail. The static scenic spot network of Jiuzhai Valley is shown in Figure 1. In order to establish the spatial-temporal network of scenic area, it is assumed that the time intervals on the time axis are all the same, and the initial departure time and unit time interval are set as t and σ respectively. Then, the time-extended network can be described in Figure 2.

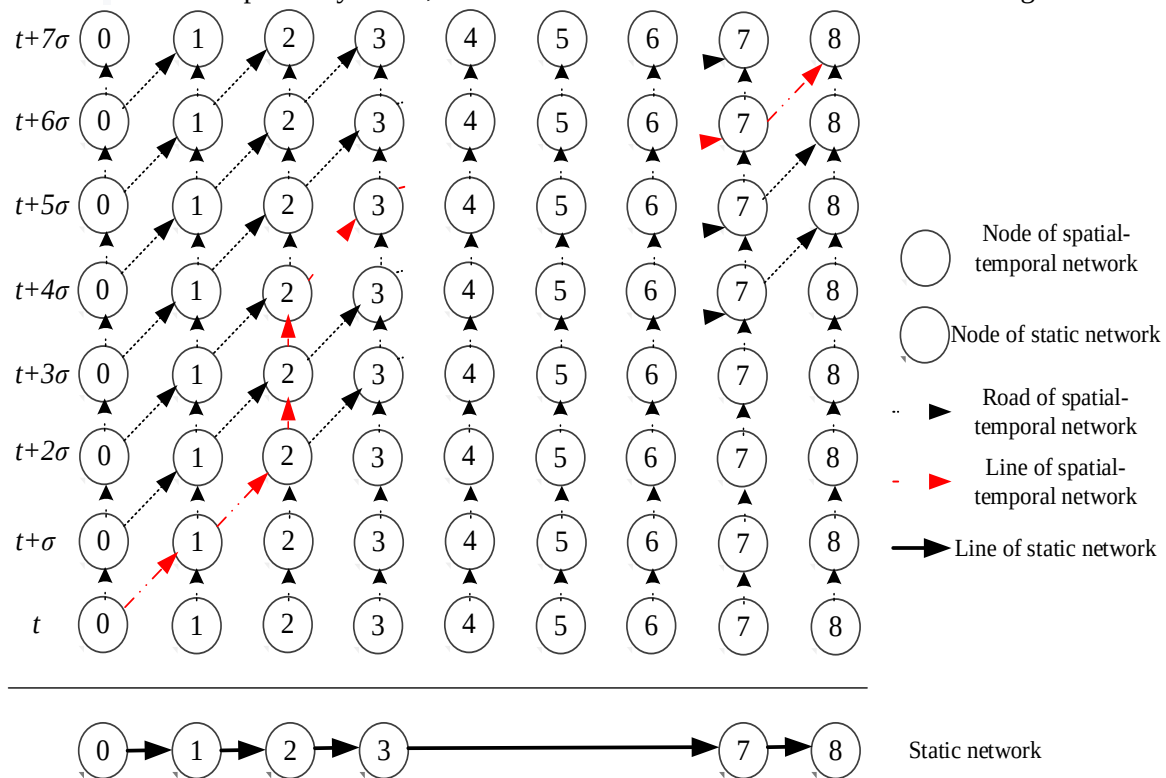


Figure 2. Schematic diagram of spatial-temporal network.

As shown in Figure 2, tourists start from the entrance at time t , arrive at scenic spot 1 (Penjingtan) at time $t + \sigma$, and finally arrive at scenic spot 8 (Changhai) at the time $t + 7\sigma$. The spatial-temporal tour lines of this tourist can be expressed as $(0, 1, t, t + \sigma)$, $(1, 2, t + \sigma, t + 2\sigma)$, $(2, 3, t + 2\sigma, t + 3\sigma)$, $(3, 7, t + 5\sigma, t + 6\sigma)$ and $(7, 8, t + 6\sigma, t + 7\sigma)$. According to the example above, it is easy to get the definitions of spatial-temporal node and spatial-temporal line in scenic area.

Spatial-temporal node: each node in the spatial-temporal network of scenic area is called spatial-temporal node. In Figure 2, 0, 1, 2, 3, 4, 5, 6, 7, and 8 are all spatial-temporal nodes. Each spatial-temporal node represents the state of one scenic spot or entrance at a certain moment, and each spatial-temporal node has a certain capacity of tourists.

Tour time: tourists often choose scenic spots according to their own preferences in the process of scenic area tour, and the tour time in each scenic spot is called tour time. As shown in Figure 3, the tourist stays at scenic spot 2 (huohuahai) for sightseeing during the period of time $[t + 3\sigma, t + 5\sigma]$, and the tour time is 2σ .

Spatial-temporal tour line is connected by space-time nodes of the scenic area, which is used to express the real-time visiting status of tourists in the scenic area. The route indicated by the red arrow in Figure 3 can be represented as $(0, 1, t, t + \sigma) \rightarrow (1, 2, t + \sigma, t + 2\sigma) \rightarrow (2, 3, t + 2\sigma, t + 3\sigma)$

$\rightarrow (3,7,t+5\sigma,t+6\sigma) \rightarrow (7,8,t+6\sigma,t+7\sigma)$ by spatial-temporal tour line, which is one of spatial-temporal tour lines.

Spatial-temporal network: there are so many different scenic spots and so many tourists in the scenic area, and it's not sure about the tour order of each scenic for different tourists, that is, there will be more than one Spatial-temporal node and spatial-temporal line in the scenic area, thus constituting a complex spatial-temporal network of the scenic spot. As shown in Figure 3, the time-space network of scenic area is a hierarchical network with time and space characteristics.

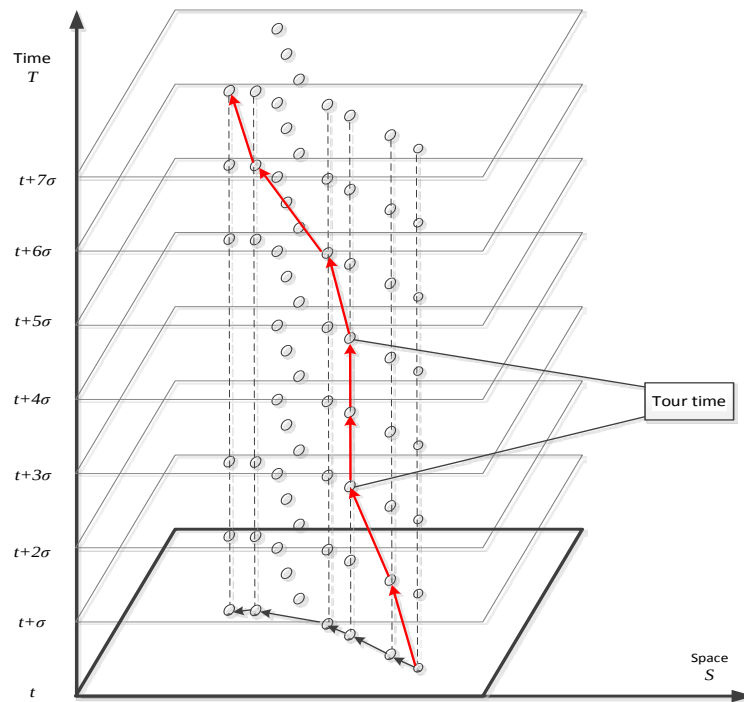


Figure 3. Schematic diagram of spatial-temporal tour line.

3. Conclusion

Firstly, the smart scenic area with multiple scenic spots and large coverage area is defined as the research object of this paper, and the concept of smart scenic area with multiple scenic spots is defined. Secondly, the paper expounds the construction process of the spatial-temporal network of smart scenic area with multiple scenic spots. And it is an important basis for tourist scientific management in smart scenic area. Above all, it provides a theoretical basis for the upgrading and transformation of scenic area management mode due to information technologies such as Mobile Internet, big data, artificial intelligence and remote sensing technology.

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