Design and Implementation of Intelligent Transportation System

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Abstract

This paper analyses the characteristics of urban road traffic flow data, and designs a traffic flow prediction method based on the traffic flow distribution pattern obtained by cluster analysis to improve the prediction accuracy. Based on this, an intelligent transportation system model is established to predict urban road traffic flow timely and effectively, improve the efficiency of road network operation and facilitate people to travel.

Keywords

Traffic Flow Clustering ,BP Neural Network,GIS, Intelligent Transportation.

1. Introduction

Intelligent transportation system (ITS) is the automatic identification of vehicles and people on specific traffic roads. It intelligently analyses key traffic management objectives, improves traffic efficiency and optimizes traffic order. The goal of ITS is to display road information to travelers timely and accurately. It is an important means to realize the intelligent management of urban traffic, an important part of building a modern city, and a convenient way for residents to understand the traffic situation. In this way, people can reduce the time spent on the road, improve the efficiency of the city, and also alleviate the environmental pollution caused by traffic congestion.

2. Road Traffic Flow Excavation

2.1 Cluster Analysis of Traffic Flow

Traffic flows on road networks have different spatial patterns. We analyze the "line" mode of traffic flow in urban main roads. Clustering analysis is a commonly used data mining analysis method. Based on the idea of clustering analysis, we cluster traffic flow data distributed in the road network space, which have similarity and spatial correlation, and find the distribution pattern of road traffic network. According to the distribution of data obtained by clustering analysis, it can be used as a pretreatment step of other algorithms. By analyzing the characteristics of each cluster, some specific clusters can be further analyzed and processed. Therefore, we can use the results of cluster analysis as the prior knowledge of traffic flow forecasting.

K-means algorithm is the simplest unsupervised learning algorithm in clustering. The method is to randomly select the number of classifications known beforehand for rough classification, then modify them according to certain principles, satisfy certain optimization methods, and calculate more reasonable classifications iteratively.

K-means algorithm method:

(1) Given the value of k, k points are randomly selected as the initial central point in n samples.

(2) Calculate the distance from the remaining n-k sample points to the K initial centers and assign them to K classes according to the nearest principle.

(3) Recalculate the mean value of K classes as the central point of the next calculation, calculate the distance from each sample to the new central point, and assign it to K classes according to the nearest principle.

(4) Repeat steps (2) and (3) to stop the iteration if the mean value of the initial center is not changed greatly or a certain range is satisfied.

K-means clustering often uses common Euclidean distance to measure similarity. Euclidean distance function is used to treat different attribute data equally. Only data sets with uniform distribution can be found. For spatial objects, clustering should consider not only the similarity of attributes, but also the spatial proximity of objects. In this paper, the spatial weighted distance is introduced into K-means clustering algorithm to replace the common Euclidean distance, that is, the reduced dimension traffic parameters speed, flow and occupancy are weighted to calculate their distance, in order to search the pattern with the highest similarity.

2.2 Traffic Flow Prediction Algorithms

Feedforward neural network is a hierarchical arrangement of neuron units. Each layer is composed of multiple node neurons. Node neurons in the same layer are not connected with each other. Neighboring two layers of node neurons are connected in two pairs. The output of the former layer of node neurons is the input of the latter layer of node neurons. BP algorithm (back propagation algorithm) is one of the most commonly used learning algorithms for feedforward neural networks. In the practical application of artificial neural networks, many artificial neural networks adopt networks or their changing forms. Figure 1 shows the structure of the neural network.

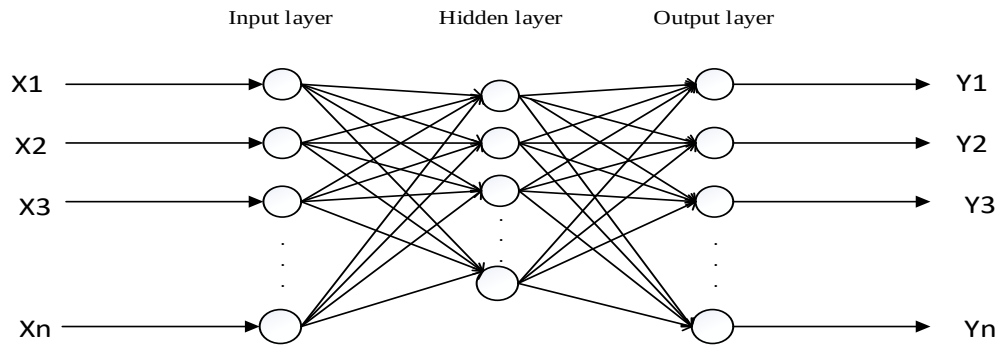

Fig.1 BP model neural network structure

The characteristic of BP neural network model is that there is no feedback connection between the neurons in eacTh layer and the neurons in the adjacent layer. Neural networks are generally stratified, i.e. input layer, hidden layer and output layer. The hidden layer can also be omitted, which depends on the purpose of the study. The ratio of initial weights to thresholds is arbitrarily given. Learning is to gradually adjust the weights and thresholds so that the actual output of the network is consistent with the expected output. The weight coefficients of BP neural networks without hidden layers have the characteristics of regression coefficients, which can be used in regression applications. However, when using BP neural networks to classify and predict, it is necessary to add hidden layers to improve the approximation degree.

Among them, the burst function of hidden layer neurons is S-type, and the output neurons are linear, which can approximate any function tangentially.

Type S1: Tansig (x)

$$f(x) = \text{tansig}(x) = (e^{x} - e^{-x}) / (e^{x} + e^{-x}) \quad (1)$$

Type S2: Logsig (x)

$$f(x) = \text{logsig}(x) = 1/\,(1 + e^{-x}) \quad (2)$$

Purelin type:

$$f(x) = \text{purelin}(x) = x \quad (3)$$

The guiding principle of network learning is to modify the weight of the network so that the error function decreases along the direction of negative gradient

3. Establishment of Intelligent Transportation System

3.1 Summary of Intelligent Transportation System

Intelligent Transportation System (ITS) is an important part of modern urban construction, which realizes intelligent management, prediction and ultimately provides various services to the public. Intelligent transportation system is required to calculate and predict the congestion of each road in the city conveniently and quickly, and to express the information of urban roads to the public in an intuitive and visual way.

The system is based on the basic data acquisition vehicle GPS data to display real-time traffic flow and forecast traffic flow information. According to the measured GPS data and the calculation of GIS electronic map, the real-time traffic flow information of the selected road is displayed, and then the traffic flow in the next 24 hours is forecasted and analyzed according to the forecasting algorithm in this paper. The process of traffic flow shown in this paper is as follows:

(1) Electronic map preprocessing;

(2) Geographical location parameter allocation;

(3)Map matching and data reading;

(4) Computing the data of congestion index, speed, congestion grade and so on.

(5)BP neural network combined with cluster analysis is used to predict traffic flow. The logical structure of real-time road condition and traffic flow prediction is shown in Fig. 2.

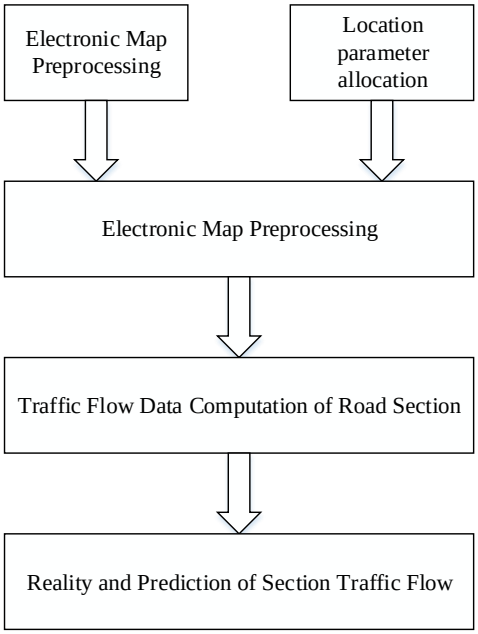

Figure 2 Real-time traffic flow display and prediction logic structure diagram

The working process of the system is divided into four modules: electronic map preprocessing module, GPS data preprocessing module, map matching module and road traffic congestion prediction module, as shown in Figure 3. The first three modules are the preparatory stage, through the work of these three modules, we can build a database-based system. Its workflow is that the first three modules complete data exchange through the database, and finally use the processed data for the final future

traffic flow calculation and prediction analysis. This makes the final processing data more pertinent and accurate, and related to real-time traffic and historical traffic, but not interfering with each other.

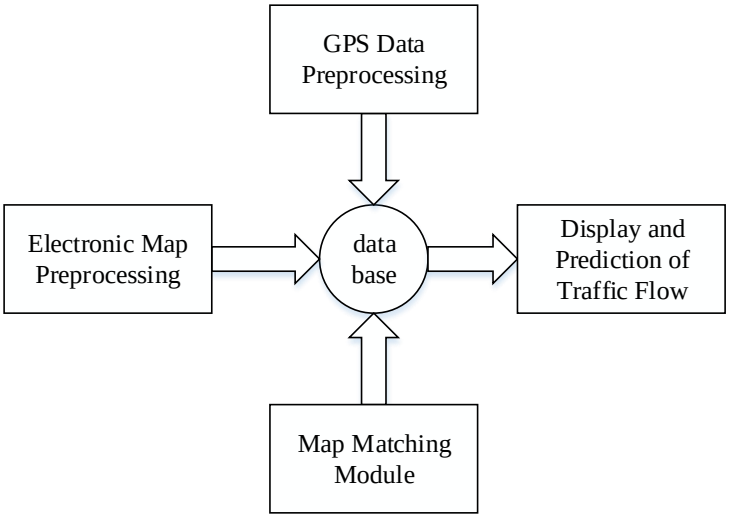

Figure 3 Analysis Diagram of System Function Modules

3.2 Main Functions of the System

(1) Map Location Function Display

In the map positioning and display subsystem, the external data is introduced into Baidu GIS platform to realize data binding. Through data binding, data is displayed by graphical objects in maps. Real-time display of the actual location of the vehicle is realized by cyclic access to the database. In the process of map positioning and display, there are mainly the following steps: the determination of display symbols, the establishment of user vehicle targets, the search of data (including traffic flow data, vehicle location data), and the layer binding of data.

Figure 4 Real-time traffic flow information

(2) Display of Predicted Traffic Flow in Section

In the first page of the map display system, traffic flow prediction system module can be entered. By choosing the corresponding city, traffic flow information can be predicted for the next 24 hours of the city section.

Fig. 5 Forecast Traffic Flow Information

4. Summary

It is an important research content of ITS to study the various forms and laws of traffic flow and realize the fast, stable and efficient function of traffic flow model. Based on the data of traffic flow clustering, this paper designs an intelligent transportation system based on GIS. It can easily and quickly calculate the congestion situation of each road in the city, and express the detailed information of each road to the public in real time in an intuitive and visual way.

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