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Research on Short-term Traffic Flow Forecasting for Junction of Isomerism Road Network Based on Dynamic Correlation

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Abstract

Short-term traffic flow forecasting for junction of isomerism road network which consists of freeway network and urban road network, is the key technology of traffic management and intelligent control. Real-time and reliability of short-term traffic flow forecasting is directly related to traffic management and collaborative control. There are various methods that have been established to forecast traffic flow, but most of the forecasting models are constructed according to analysis of the historical and current traffic flow series in selected sections or crossings, without considering the dynamic information of related traffic network. According to the traffic flow characters of junction of isomerism road network system, the paper analyzes the relationship between the traffic flow of a certain section with other section's flow, and calculates the dynamic correlation coefficient. Following, the paper selects input variables, and establishes the Radial Basic Function (RBF) neural network model for prediction on the basis of dynamic correlation coefficient. Finally, the paper takes the G2 freeway and Beijing road network that consists of the junction of isomerism road network as an example to forecast the short-term traffic flow. The result of forecasting is very accurate, and the relative errors are within the 15%. It indicates that the model could be used to forecast the short-term traffic flow for junction of isomerism road network system.

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1. Introduction

With the expansion of urban, increasing the economic ties between the rural and urban, as well as the amount of motor vehicle ownerships, some of the freeways which are mainly used for median-and-long transportation tasks, have taken a large number of suburbs, commuter and other transportation tasks. In this case, the junction of isomerism road network has taken a lot of traffic conversion demands from freeways to urban road network or from urban road network to freeways. As a result, the junction of isomerism road network system causes congestion frequently, and especially affects efficiency of the whole network. Therefore, real-time and reliability of short-term traffic flow forecasting is directly related to traffic management and collaborative control.

So far, there are many kinds of forecasting methods, including time series model, neural network method and so on, and some of them have been applied successfully to achieve short-term traffic flow forecasting. Now, linear and nonlinear predictive models which include time series model, nonparametric regression model, neural network prediction method, support vector machine method, Kaman filtering method, the combination of forecasting methods based on Bayesian and so on. Xie et al. (2011) proposed a polynomial distributed lags model for short-term traffic forecasting. Li and Liu (2012) proposed an improved prediction method of optimized BP neural network based on modified particle swarm optimization algorithm to predicate the short-term traffic flow. Kuang and Huang (2004) established RBF neural network method for short-term traffic flow prediction. Zhou and Jia (2012) used RBF neural network method and forecasted short-term flow of the urbanized section of a freeway. Li et al. (2013) established combination of predictive models for short-term traffic flow prediction. More recently Wang et al. (2012) put forward a new method called improved Bayesian combined model to forecast the short-term traffic flow based on the improvement of the traditional Bayesian combined model and this model was more sensitive to the accuracy of each basic prediction mode1. In recent years, Xia et al. (2011) considered the spatial information of related traffic network, and consider much spatial-temporal information such as spatial connectivity of the traffic network and time latency of traffic flow series, and got more accurate results. In fact, most of them mainly focus on the time series which reflects trends and coherence of themselves. Although some papers consider spatial-temporal correlation, they think the correlation coefficient is static.

Therefore, according to the spatial distance and the traffic conditions between different sections, the paper calculates time latency of traffic flow series, and analyzes the dynamic correlation coefficient of traffic flow. Then the paper calculates the correlation coefficient, makes sure the input and output variables, and establishes the RBF neural network model to forecast short-term traffic flow for junction of isomerism road network.

2. Dynamic correlation analysis for traffic flow

Correlation analysis is what measures the time series' correlation of itself, and finds out the interior rules. Take the time series $X = \{x_t | t = 1, 2, \cdots, n\}$ as an example, the time series' correlation means that the value of time series at time t is relevant to the value before time t. Dynamic correlation is what researches the time series' correlation changes as the time changes. In other words, dynamic correlation coefficient is changing as time changes, and the coefficient could find out rules objectively.

The sections of junction of isomerism road network system could be directly or through other sections connected. Although the traffic flow of a section is relevant to others', the correlation is different because of the distance between the different sections, as well as the location of the section. In junction of isomerism road network, the upstream section of the traffic flow will directly affect the downstream section of the traffic flow, and the influence delays. In other words, the upstream sections of traffic flow have to take time when they reach the downstream sections, and have a effect on downstream section.

Therefore, based on the basic principles of the time series correlation, the basic idea that calculates the dynamic correlation coefficient is relative to the traffic flow characteristics of the spatial-temporal, and the distance of the different sections and so on. The calculation formula is as follows: