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RESEARCH PAPER

Traffic State Forecasting of Typical Roads in Beijing

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Abstract: The comprehensive analysis of traffic states are effective ways to eliminate some traffic problems and enhance the supervising ability of the traffic management departments, which includes real-time monitoring, evaluation and prediction the states of the entire city. With analyzing the traffic flow characteristic on several typical roads in Beijing and summarizing the existing traffic prediction models, this paper proposes a combination forecasting model. It is mainly based on the nonparametric regression model. The combination of Fourier's history estimated model, nonparametric autoregressive model and nonparametric neighborhood regression model are used to predict the traffic state of typical Roads. Considering the reality of the traffic flow information collection system of Beijing and the needs of predicting information released by graphical way in the future, the paper also presents the heterogeneous data fusion methods and road traffic code model.

Key Words: urban traffic; traffic state foresting; non-parametric regression; prediction model; traffic characteristics

1 Introduction

The study of traffic flow prediction can be dated back to the 1970s. Nowadays, such models are normally categorized into two types according to the data sources. One is an off-line prediction based on dynamic Origination-Destination (O-D) matrix and the other is an off-line or on-line prediction based on historical data. The former belongs to predicting the macroscopic level, which needs large-scale O-D data and road network infrastructure data. The latter is often adopted to predict both the macro and micro level problems. The predicting data originated in the fixed detection loop, microwave detector, ultrasonic detector, video detector, that can also be derived from floating vehicles. The model and method include historical average method, time series method, linear regression model, nonparametric regression model, traffic simulation and dynamic traffic assignment model[1,2].

The model based on statistical methods such as the historical average model is able to solve the changing traffic flow problems indifferent times, but still cannot solve the unconventional and burst traffic condition prediction. The linear regression model is more mature but with relatively lower computational complexity. Its operation is simple but has poor applicability and weak timeliness. Therefore, it is only applicable for specific range of flow, and not timely for error correction. The nonlinear prediction method reflects the characteristics of the traffic system with nonlinearity, the accuracy and computational complexity are high, but the theory has not been widely tested. The prediction method based on traffic simulation theory analysis has fully theoretical system. It considers some complex influencing factors with high computational complexity. Thus, it is difficult to adapt to the large-scale traffic systems. Traffic system has the historical regularity, time-variant and spatial nonlinear correlation. A single model and method have both the advantages and disadvantages and cannot completely and accurately reflect the essential characteristics of traffic flow. It is difficult to accurately reflect the road traffic movement status. Hence, it is a viable approach for integrated traffic flow forecasting modeling[1–5].

2 Typical road traffic operating characteristics in Beijing

2.1 Data acquisition and data description

All data are obtained from the Real-time Traffic Monitoring Detector System in Beijing. The case data are from expressway connecting line between Huayuan North Road and Xueyuanqiao Bridge. A microwave detector was installed on

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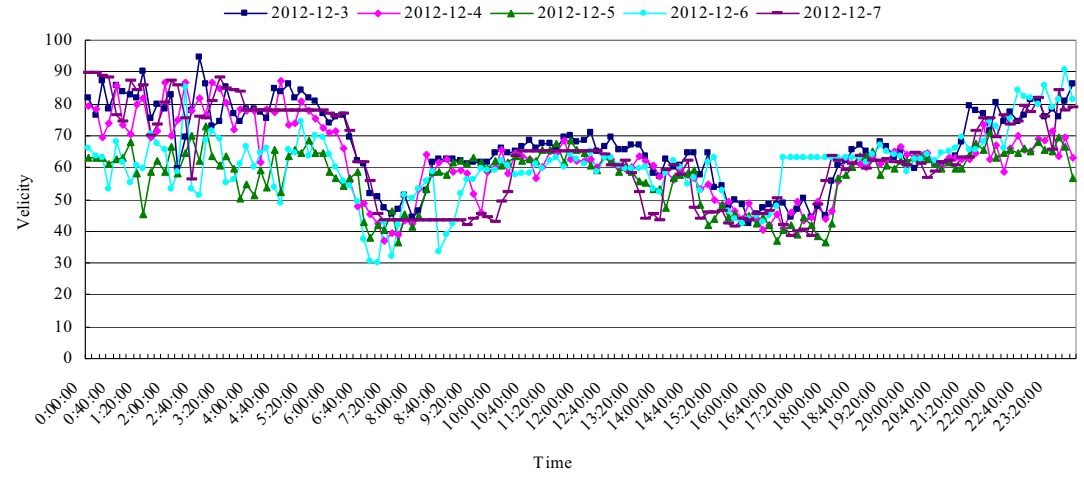
the roadside with a detecting cycle of 2 min. The detector collected flow and speed. The upstream and downstream monitor detector was positioned on the same side as the microwave detector. The interval distance was 500 meters. Data was collected from 00:00 on December 3th, 2012 to 24:00 on December 9th, 2012 with a total of 30,240 sets being collected.

2.2 Typical road traffic operating characteristics in Beijing

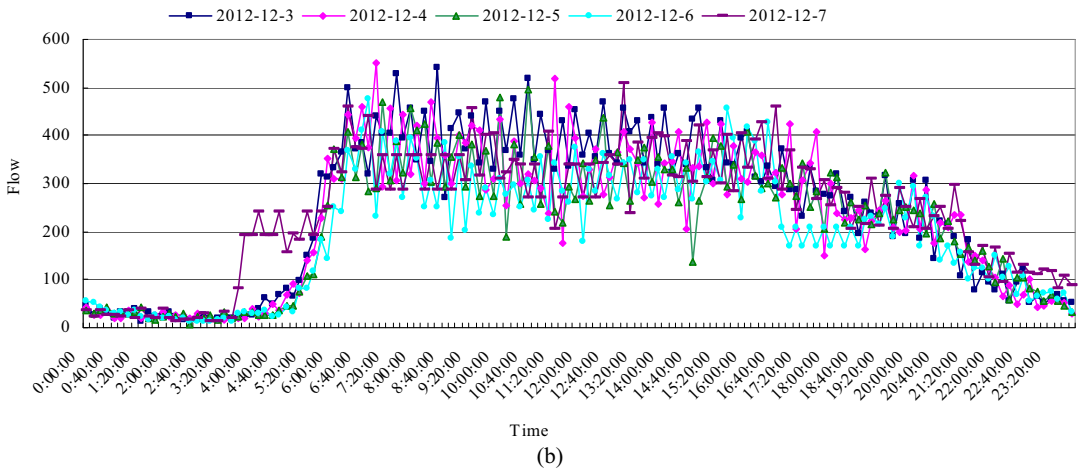
The traffic flow of the expressway and its connecting lines has significant daily traffic distribution characteristics. Based on 24 hour traffic flow starts from free flow period of driving at night, gradually into steady flow of normal driving, then into congested flow status until it reaches the stage of queuing saturation. In this process, velocity goes down with flow increasing during free flow status. Due to some factors, velocity varies as flow is increasing until it decreases when the state of steady flow is reached. Furthermore, the downward trend speeds up after getting into the congested flow status. However, when velocity reaches a certain degree, the congestion starts to dissipate and velocity sharply rises to steady flow status. Nevertheless, it perhaps turns up another condition of congestion. Meanwhile, velocity goes to zero with the lift to congestion phenomenon, speed and flow rise to steady flow conditions again.

The 24 hour variation of velocity and flow of the typical road of the expressway and its connecting lines is shown in Fig. 1 during the weekend and working day.

On weekdays, the flow of ring lines and expressway connecting lines show distinct characteristics. The flow of ring lines takes 80.90% of daily traffic in 16 hours from 7:00 am to 22:00 pm. Meanwhile, connecting lines takes 83.91%. The flow of the morning peak is mostly on Monday, while the evening peak is on Friday. The morning peak appears fast from 7:30 am to 10:00 am. However, the evening peak appears slow, from 14:00 pm to 18:00 pm. At noon, it comes at a not obvious. On the whole, the change of the flow shows a saddle-type trend as in Fig. 2.



(a)



(b)

Fig. 1 24 hour velocity and flow status of expressway connecting lines during a working day