SUMMARY OF Ph.D. DISSERTATION

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Title

Analytical models of time-dependent traffic flow on a continuous plane and a network space and their applications to urban analysis

Abstract

In the fields of traffic engineering and operations research and other traffic-related disciplines, various traffic flow models have been developed. These models have played important roles in solving practical traffic problems. So far, however, few models have been developed which explicitly considered time variations of traffic flow. There are, however, lots of traffic problems that cannot be analyzed satisfactory without considering temporal fluctuations of traffic flow. This study presents a mathematical framework for deriving time-dependent flow and provides some results calculated in some ideal city models with typical road networks.

In the theory of continuous traffic flow modeling, various studies focusing on spatial traffic patterns have been proposed. These studies are concerned with how spatial traffic patterns are influenced by (1) the shape of the city, (2) the geometrical arrangement of the network, and (3) the distribution of endpoints of trips over the city. The proposed method provides analytical tools to derive time-dependent traffic flow when a destination arrival-time distribution is given in addition to the above assumptions. The present study allows us to analyze spatial-temporal traffic patterns during the peak commuting period and provides us insights into how arrival-time patterns influence traffic over the urban transport infrastructure. Three models assuming typical network patterns, Euclidean metric, circular-radial metric, and rectangular metric, are considered and flow is derived as a function of space and time. This study also derives time-dependent flow on a network over which endpoints of trips are continuously distributed. These models show that the peak congestion period emerges even when the commuters' arrival time is uniformly distributed on a finite range of the time axes.

The analytical models developed in this study are useful in analyzing various traffic policies and flexible in generalizing assumptions such as arrival-time distribution and trip density.