B.4 Adaptive Estimation of Speed-Density Relations for Online Network Traffic Prediction

Hani S. Mahmassani, Northwestern University
Xiao Qin, Brudis & Associates, Inc.

Abstract:

Speed-density relations with specifications that are variants of the Greenshields model are used extensively in dynamic traffic assignment models. Real-time versions of these models have been proposed for online traffic estimation and prediction, in quasi-continuous interaction with traffic sensor data. The problem addressed in this paper is the specification and adaptive estimation of a dynamic traffic flow model driven by real-world observations for the purpose of online simulation-based dynamic traffic assignment application.

Specification of the dynamic speed-density relation incorporates the physical concept in continuum and kinetic models, coupled with the structural formulation of the transfer function model which is used to represent the dynamic relationship. The model recognizes the time-lagged response of speed to the influential factors (speed relaxation, speed convection and density anticipation) as well as the potential autocorrelated system noise. In the context of real-time operation, a rolling-horizon framework is utilized for the adaptive calibration of dynamic speed-density relations to reflect more recent measurements.

Numerical tests using actual loop detector data are conducted to evaluate the dynamic model specification in a standalone manner before integrating the model into a real-time DTA system. The overall conclusion from the results is that the proposed dynamic model is preferable in the context of real-time application to the use of conventional static traffic flow models to predict time-varying traffic state variables, considerably extending the range of application of Greenshields' original work.