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著者(和文)	Dahiya Garima
Author(English)	Garima Dahiya
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論 文 要 旨

THESIS SUMMARY

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学生氏名： Student's Name	Garima Dahiya	指導教員（主）： Academic Supervisor(main)	Toru Seo
		指導教員（副）： Academic Supervisor(sub)	

要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Traffic congestions is causing poor road traffic performance that has negative impacts on economic productivity, environmental quality, and safety. Earlier these kinds of problems were usually addressed through development of new infrastructure however, building new transportation networks is neither an advantage in terms of cost nor it is a sustainable solution. Therefore, it is required to use the existing road network in an optimized manner, together with a shift towards sustainability. For doing so, one of the several challenges is to provide accurate information about current traffic state (flow q, density k, speed v). Understanding the current traffic flow characteristics provides essential input for design, planning, operations, traffic management and control, and information provision for route choice guidance.

Traffic state variables are vital for traffic control and operations however, obtaining these parameters simultaneously is difficult as they are not measured everywhere due to the associated financial and technological limitations. On this account, the process of inferencing these variables on a road segment at certain spatiotemporal resolution using partially observed traffic data is referred to as traffic state estimation (TSE).

The Fundamental diagram (FD) describes the empirical relationship between traffic states and contains remarkable information about traffic characteristics. Hence, sound mathematical models that better represent the FD prepare a solid foundation for traffic flow analysis and efficient traffic control. Researchers have been examining simple and low computational FDs that can sufficiently describe the traffic dynamics. Once it is known, all that is needed for TSE is to locate where the system is on the FD at any desired moment. These allow in describing the evolution of traffic dynamics and lead to smart solutions to optimize the existing traffic system.

The aim of this dissertation is to systematically analyze various existing FDs and develop a physical model-based TSE method by utilizing data assimilation (DA) framework. This dissertation consists of seven chapters. In chapter 1, the background, objectives, and outline of the thesis are introduced. Chapter 2 summarizes the literature review on fundamentals and traffic state variables, FD and TSE and discusses the scope of the doctoral research. Chapter 3 discusses about the traffic data collection methodologies, the complete trajectory data utilized for this research namely, Zen Traffic Data (ZTD) and advantages associated with utilizing ZTD over other high-tech trajectory datasets. Moving on, in this research towards

analysis and modeling of FDs and TSE methods, three main objectives are introduced.

Chapter 4 describes the first objective of this dissertation which contributes to the empirical analysis of various existing speed-density (v-k) FDs by estimating and studying their parameters at varying spatiotemporal resolutions using ZTD, followed by a theoretical investigation with respect to the stationarity and continuity of traffic flow. The objective is twofold: first, to identify a model a.) with less complex form; b.) based on '*weaker*' assumptions; c.) reasonably achieves mathematical elegance and empirical accuracy, which are all desirable to have; and second, to make the validation more reliable by conducting it over various space-time resolutions which provides theoretical and practical support to practitioners in decisively choosing most workable FD at a particular resolution.

Over past decades, researchers have also contributed to development of several TSE methods using probe vehicle data including ones that don't rely on any '*strong*' assumptions, such as explicit priori knowledge of traffic dynamics like FD, or historic data, which renders the method robust against uncertain traffic phenomena. However, their estimation capabilities have not been validated using high-resolution, complete trajectory data with wide coverage. Chapter 5 elaborates the second objective of this dissertation that contributes to the analysis of a '*weaker*' assumption-based TSE method (proposed by Seo *et al.*, (2015b)) at different spatiotemporal resolutions and probe penetration rates using ZTD.

The third objective of this dissertation contributes to the development and implementation of a physical model-based TSE method and is described in chapter 6. To improve the estimation capability at fine space-time resolution, using fewer probe vehicles, in both the regimes, free-flow and congested, and in complete space-time domain, it extends the '*weaker*' assumption-based approach to estimate the traffic state more accurately by utilizing a DA framework. In it, the state variable, density k, is estimated by first, simulating the k obtained from a physical model (Cell Transmission Model) which are then integrated with the observed traffic states (k and v from probe data) using Ensemble Kalman Filtering technique. In addition, the parameters of physical model are obtained by automatic calibration of a triangular FD. The results from this adaptive calibration and estimation show that the accuracy of estimating the traffic state using this approach increases and the estimated k corresponds well with the k computed using Edie's generalized definitions (Edie, 1963) and 100% trajectory data (ground truth).

In chapter 7, conclusions, achievements, and future research directions are summarized.