論文の内容の要旨

Driving behavior analysis at basic segment bottleneck on expressways （高速道路単路部ボトルネックとする追従挙動の分析）

楊　燕

This research presents a simulation study of probabilistic congestion occurrence at expressway basic segment bottlenecks well known as sag section in Japan with individual variations in car-following behavior obtained from an actual sag section. A sag section is a road segment on an expressway in which the vertical slope increases at a small but constant rate. It is impossible to predict congestion from detector data because the only observable flow condition changes happen right at the time congestion occurs. The propagation of unnoticed deceleration due to the vertical slope increase has long been researched as the cause of congestion. Perturbation amplifies in dense vehicle platoon consisted with drivers of varying car-following behavior. In this research, a car-following behavior model considering both the intra-driver variations and inter-driver variations is utilized and calibrated with field observation data. The variations are described with parameter distribution of car-following model. A simulation to reproduce traffic condition with the estimated parameters is thus proposed and validated in order to predict the probability of congestion occurrence at basic segment bottlenecks as well as test possible countermeasures to prevent and alleviate bottleneck congestion.

Two datasets containing all together 875 trajectories during congestion formation at the tomei yamato sag section are used in car-following behavior modeling. One is a dataset of 393 trajectory data observed in 4 days including position, speed and acceleration recorded every 1/30s along a 1.2 km sag section with 11 fixed road side cameras is analyzed for individual variations in car-following behavior. The other is a dataset of 482 trajectories observed for around 1km at the same sag section with different starting point. Trajectories of independent vehicles which do not react to the driving behavior of preceding vehicle and vehicles already involved in congestion are excluded from analysis. A car-following model considering both the intra-driver variations and inter-driver variations is utilized. The car-following model is consisted of speed difference and spacing difference to its desired spacing with a time lag as well as an unnoticed deceleration caused by the vertical grade change at sag section. After thorough

distributed parameter values is proposed. The platform is designed to reproduce the probabilistic nature of traffic congestion occurrence at a bottleneck of sag section including the effect of vertical slope increase. It was carefully validated with different initial settings to make sure its capability of accurately reproducing the real condition. It provides a platform for analyze how different key components of the driving behavior, leading car behavior affecting the probability of congestion occurrence as well as a tool to quantify the effect of countermeasure like Adaptive Cruise Control (ACC) system. An interactive user interface was made to visualize the congestion formation progress. It reproduces congestion occurrence by changing the order of vehicles within the same platoon, which will help us to analyze the parameters of vehicles tending to cause congestion. It enables us to study the range of car-following parameters that causes propagation and amplification of speed reduction. Three kinds of drivers are observed in simulation: aggressive, negligent and nimble drivers. Collision and sudden stop occurs in 5-min platoon of aggressive drivers. Congestion occurs in 5-min platoon of negligent drivers, while no congestion occurs in 5-min platoon of nimble drivers at sag section. The simulation successfully reproduces the tendency that the congestion occurrence probability grows with traffic demand. The congestion occurrence probability is obtained through simulation with estimated parameters. A higher traffic demand will cause higher probability of congestion occurrence at sag section, which is the same in reality. With this platform, the effect of introducing ACC system was also studied. Apart from the ACC penetration rate, two different ACC introduction schemes of 1) Random introduction and 2) Intentional introduction by replacing vehicles with certain features, e.g. aggressive, negligent and nimble drivers, is simulated and compared.