THE ROLE THAT CONNECTED AND AUTOMATED VEHICLES CAN PLAY IN RE-ORGANIZING TRAFFIC FLOW: WORK ZONES AND EMERGENCY SERVICES

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Certificate of Original Authorship

I, Yun Zou declare that this thesis, is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the School of Civil & Environment Engineering at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise reference or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis. This document has not been submitted for qualifications at any other academic institution.

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List of Publications

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Zou, Y., & Qu, X. (2019). On the Impact of Emergency Incidents on the Freeway: A Full Velocity Difference (FVD) Model Based Four-Lane Traffic Dynamics Simulation. In Smart Transportation Systems 2019 (pp. 165-174). Springer, Singapore.

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List of Abbreviations

CAV	= Connected and Automated Vehicles;
HDV (or MV)	= Human-driven Vehicles (or Manual-driven Vehicles);
CA	= Cellular Automata;
FVD	= Full Velocity Difference;
ICAM	= Improved Cellular Automata Model;
CCAM	= Cooperative Cellular Automata Model;
AFV	= Anticipated (Adjacent) Following Vehicle;
APV	= Anticipated (Adjacent) Preceding Vehicle;
SVM	= Support Vector Machines
k-NN	= k Nearest Neighbor
NGSIM	= Next Generation Simulation
US-101	= U.S. Highway 101
I-80	= Interstate 80 Freeway
SITRAS	= Simulation of Intelligent Traffic System
sEMA	= symmetric Exponential Moving Average
VT-micro	= Virginia Tech microscopic
ILMCS	= Intelligent Lane Merge Control System
ITS	= Intelligent Transportation System
V2V	= Vehicle to Vehicle
V2I	= Vehicle to Infrastructure
USDOT	= U.S. Department of Transportation
CVRIA	= Connected Vehicle Reference Implementation Architecture
DSRC	= Dedicated short-range communication
CACC	= Cooperative Adaptive Cruise Control
OVM	= Optimal Velocity Model
GFM	= Generalized Forced Model
TTC	= Time to Collision
ANN	= Artificial Neural Network
LSM	= Least Squares Method
GA400	= Georgia State Route 400
WLSM	= Weighted Least Squares Method
RMSE	= Root-Mean-Square Error
WLSMT	= Weighted Least Squares Method with Data Transformation
OLSMT	= Ordinary Least Squares Method with Data Transformation
OLSM	= Ordinary Least Squares Method

Abstract

The extensive progresses in computer science and communication technology in recent decades facilitate the development of the connected and automated vehicles (CAV). Since the emergence of the concept, the commercialization of CAV has been looked forward to providing an effective tool to the regulation of the freeway re-organizing traffic flow who normally initiate the evolvement of the congestion. To analyse the benefits of the CAV on traffic dispersion, the re-organizing traffic in the work zone and the incident-affected zone (under emergency services) were adopted as two cases of non-recurrent congestion, and the microscopic simulations were conducted on the basis of various car-following models and lane-change models. Furthermore, collaborative instances were added to the traditional traffic dynamic models to emulate the motions of the CAV. Trajectories data extracted from NGSIM open-access database were applied to calibrate the Bayes-classifier-based lane-change prediction model in order to better emulate the human drivers' lane-change decision and to assist the CAV's collaborations. With the increasing percentage of the CAV, the traffic congestion on the aforementioned bottlenecks were significantly mitigated. While CAV are proved to be capable of facilitate the cooperative lane-changes, they were also trained to refuse the lane-change request if there would be great impact on the target lanes. Although the lane-changes would inevitably impact the target lanes owing to the increasing densities and the disturbances during the lane-change motions, the simulation results showed that CAV are capable of minimizing the negative effects for the entire traffic system's perspective.

Keywords

Connected and automated vehicle; Work zone; Emergency Service; incident-affected traffic; freeway; bottleneck; microscopic simulation; car-following model; lane-change model; cooperative lane-change.