Optimizing Traffic Control for Emission Reduction: the calibration of the simulation model

Jie Li[1,2,3], Henk Van Zuylen[2,3,1], Yusen Chen[2], Francesco Viti[4], Isabel Wilmink[5]

[1] *College of Civil Engineering, Hunan University, P.O. Box 410082, Changsha, PR China;*
[2] *Department of Transport& Planning, Faculty of Civil Engineering and Geosciences, TRAIL Research School, Delft University of Technology, Stevinweg 1, 2628 CN Delft,*
[3] *TRAIL Research School;*
[4] *Catholic University Leuven, Department of Traffic and Infrastructure, Faculty of Industrial Management, Celestijnenlaan 300A, Heverlee, Belgium,*
[5] *TNO Bouw en Ondergrond, Van Mourik Broekmanweg 6, 2628 XE Delft.*

Abstract

In this study the driving behavior parameters in a dynamic simulation model (VISSIM) are calibrated with real trajectories collected by image processing at an intersection in Rotterdam. The need for a better microscopic calibration of microscopic simulation programs emerges from the fact that these programs are nowadays used to estimate the emissions of pollution. This is very sensitive to details of the driving behaviour.

For the calibration, first the sensitivity of the simulation results to certain parameters has been investigated. Relevant and significant parameters are identified and adjusted such that the simulation results matched as well as possible the observed traffic and the total production of emissions.

Introduction

Accurate estimation and prediction of different aspects of traffic behavior, e.g. delays and emissions in urban cities relies on the calibration and validation of the adopted traffic models. In order to meet the required needs, microscopic simulation models are often used to simulate the traffic process in sufficient detail.

Calibration of various parameters in a simulation model is required in order to achieve sufficient validity of its outcomes. The default values of these parameters, provided by the software developers, are only applicable to rather specific circumstances, which often are not specified in detail by the software provider. The number of user-adjustable parameters is usually quite large and the calibration process is rather complex. Experienced users adapt and adjust a certain number of parameters such that the program can behave as required by a specific application. This kind of 'calibration' is in general opportunistic rather than systematic. Often practitioners select some key parameters for the calibration based on the structure of parameter in the software and their experience. Even if a procedure of calibrating parameters is good for aggregate output such as throughput, capacity, etc., it may not be good enough for model performance determined by more subtle factors, such as the traffic emissions.

Generalizability

Microscopic simulation programs are often used to analyze traffic scenarios, e.g. for assessing the impact of traffic measures such as signals. Most models have been calibrated and validated by their developers for specific situations. For instance, car following behavior is adopted from existing models with parameters that are calibrated for certain kinds of vehicles, queuing is modeled with traffic flow theory with parameters such as free flow speed, capacity and maximum vehicle density.

It is common in practice to find the optimal settings for a microscopic model using measured macroscopic parameters. E.g. Kim et al. (2005) used the distribution of travel times as characteristic of the traffic and tried to fit the observed distribution with the simulated one. Apart from questions about the uniqueness of the 'optimal' parameters, it is also not certain that the calibrated parameters give a sufficiently generic model. The model should have *predictive validity,* i.e. it should be able to predict the performance of a traffic situation that has not been used for the calibration.

This brings to new questions:

- Can a model be used in situations that differ considerably from the calibration situation?
- Are properties of the model that have not been involved in the calibration and validation, also represented in a valid way by the simulation program?

Specific examples of these questions are:

- Is a microscopic simulation model that is calibrated and validated for traffic conditions in Western countries also valid for traffic conditions in other parts of the world, e.g. China?
- If a model gives correct capacities, delays and queues in a network, would it mean that it provides detailed and valid driving behavior?

Detailed surveys have shown that VISSIM (PTV 2006), when calibrated for Western traffic, is not valid for Chinese traffic. The saturation flows as measured on intersections in China is considerably (10 to 30%) lower compared with the value measured in the intersections in The Netherlands, as shown in Figure 1.

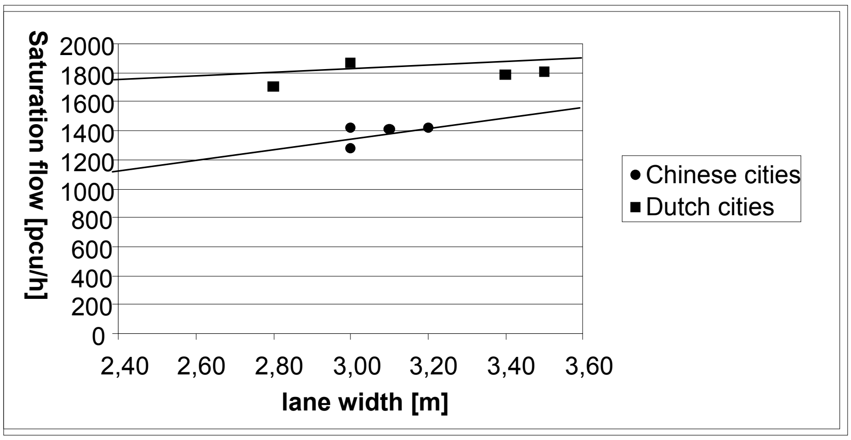

Figure 1 Dependence of saturation flows on the lane width

The second question can be made more specific by analyzing the case of emission predictions. Emissions depend on the detailed behaviour of vehicles: acceleration, speeds, deceleration and higher order terms (e.g. Keller and de Haan 2004). The reality is that the usual way of calibration of macroscopic behaviour is not satisfactory to make the results valid for emission estimation.

Fehler! Verweisquelle konnte nicht gefunden werden. shows the speed profile (speed distribution of approaching traffic as a function of the distance to the stop line) as observed (right figure) and simulated with VISSIM (left) for traffic on an intersection of Rotterdam. The differences are obvious. This has a consequence that the emissions that are calculated from the simulated trajectories are different from reality.

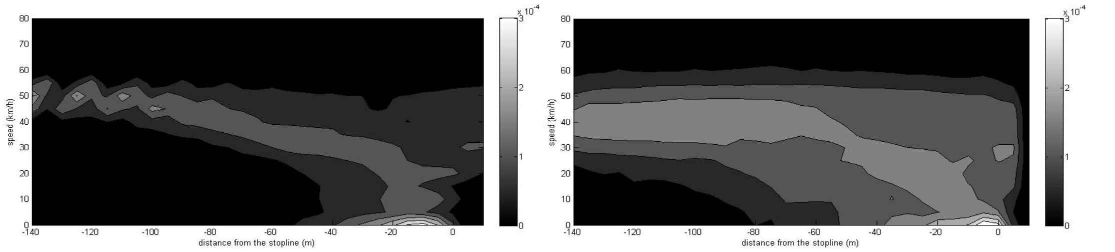

Figure 2 VISSIM speed profile (left) and the observed speed profile (right)

The objective of this article is using observed trajectories to calibrate the VISSIM model, so that the model can be suited for emission calculation.

Approach and results

Ossen and Hoogendoorn (2007) developed a method to calibrate the parameters of car following models using trajectories obtained by remote sensing. In their experiments, the images of traffic taken from a helicopter were transformed into positions of the vehicles and subsequently trajectories. In this study, the vehicle trajectories have been obtained from video observations from a high tower. The positions of the cars could be determined with accuracy of about 0.1 m. These positions were smoothed by a weighted polynomial curve fitting method, so that speeds and acceleration could be derived.

The parameters of VISSIM have to be calibrated such that the trajectories are sufficiently valid. This calibration is more far-reaching than the usual calibration on delays, travel time and queues. Very few attempts have been made to calibrate microscopic simulation models at this level of detail (Wu et al. 2003).

First a sensitivity analysis has been executed. The purpose is to identify relevant traffic behaviour parameters that have a significant influence on the simulation results.
Instead of a ‘blind’ application of a massive search procedure like a genetic algorithm (Park and Qi 2005), the parameters related to driving behaviour have been changed one by one, while the other parameters were kept constant at their default value.

Table 1 gives an overview of the parameters that have been checked for their influence on the delay, travel time, speed distribution and acceleration distribution calculated by VISSIM. When a parameter gives a significant influence on such outcomes, this parameter is selected to be calibrated in the next step.

Table 1 Overview of default parameters and tested parameters

Parameter Name		**Default**	**Unit**	**Change scale of parameter**
Parameter sets				**Urban (motorized)**
Following				
Look ahead distance	Min.	0	m	No change
	Max.	250	m	50, 60, 70, 80, 100, 150, 200, 250
	Observed vehicles	2		No change
Temporary lack of attention	Duration	0	s	No change
	Probability	0	%	No change
Car following model				**Wiedemann 99**
Model parameters	CC0	1.50	m	1.20, 1.40, 1.50, 1.60, 1.80, 2.0
	CC1	0.90	s	0.8, 0.9, 1.0, 1.2, 1.5, 1.8, 2.0
	CC2	4.00	m	2, 3, 4, 5, 6, 8, 10
	CC3	-8.00		-3, -5, -7, -8, -9, -11, -15
	CC4	-0.35		-0.1, -0.2, -0.3, -0.35, -0.4, -0.5, -0.7
	CC5	0.35		0.1, 0.2, 0.3, 0.35, 0.4, 0.5, 0.7
	CC6	11.44		5, 8, 10, 11.44, 13, 15, 20
	CC7	0.25	m/s^2	0.1, 0.2, 0.25, 0.3, 0.5, 0.7, 1.0
	CC8	3.50	m/s^2	2.5, 3, 3.50, 4, 5, 6, 7
	CC9	1.50	m/s^2	0.5, 1.0, 1.50, 2, 3, 4, 6
Signal Control				

More details about the calibration process will be presented in the full paper.

After modifying the main behavioural parameters and inputting the desired acceleration function and desired speed distribution deduced from the empirical data, the simulated speed and acceleration distribution obtained from the calibrated VISSIM model are compared against those of the empirical data, as shown in **Figure** 3 and **Figure** 4 respectively. Calibration has improved the consistency between the simulation results and the empirical data; however there are still some differences between these two data sets. The possible reasons are analyzed in the full paper.

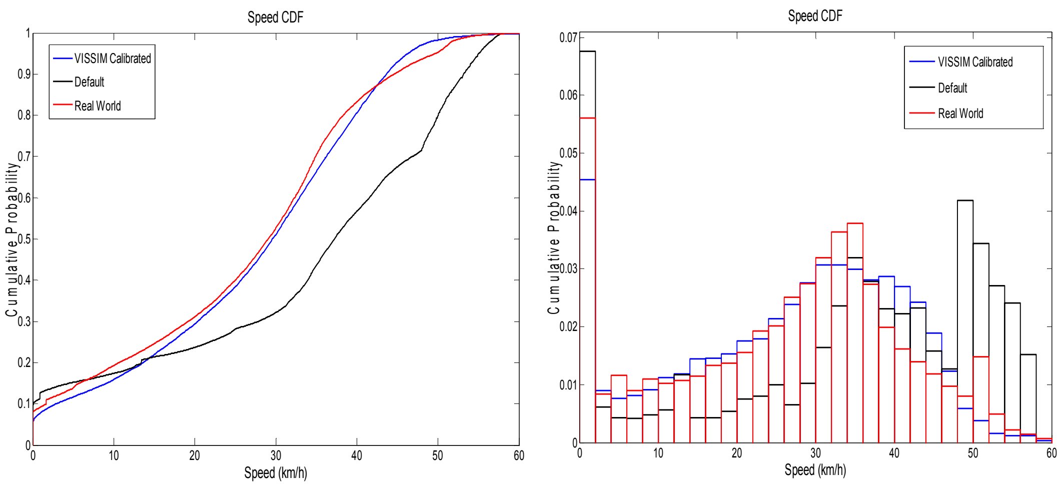

Figure 3: Speed distributions for real data and calibrated simulation data

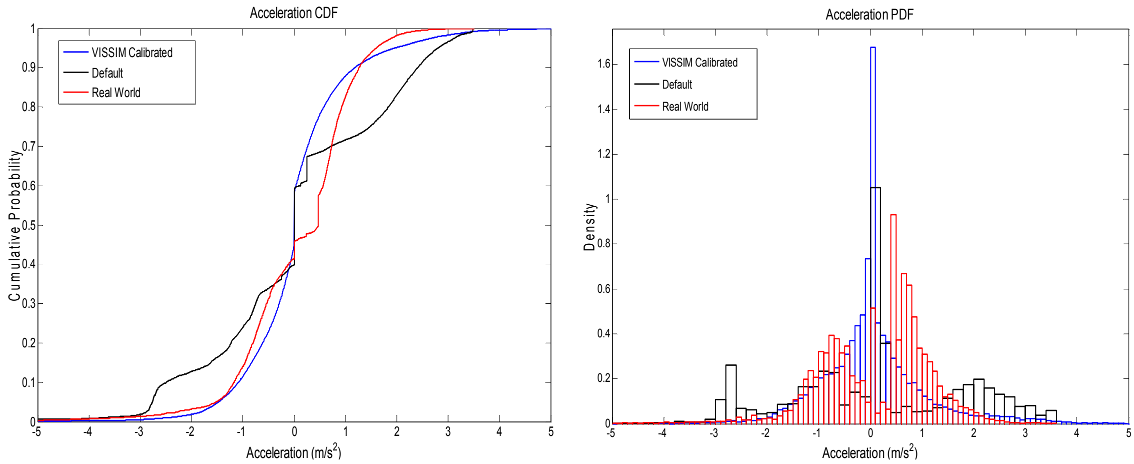

Figure 4: Acceleration distributions for real data and calibrated simulation data

ln(TAD) is an important parameter in the microscopic emission model VERSIT+ and a measure that characterizes the essential behaviour of a vehicle as far as it determines the emissions.

Figure 5 compares the *ln(TAD)* values calculated with the real data, the ones using default parameters and those estimated with the calibrated VISSIM results. The overestimation error in the large *ln(TAD)* values seems highly improved, and the simulated data is significantly more consistent with real data in that region.

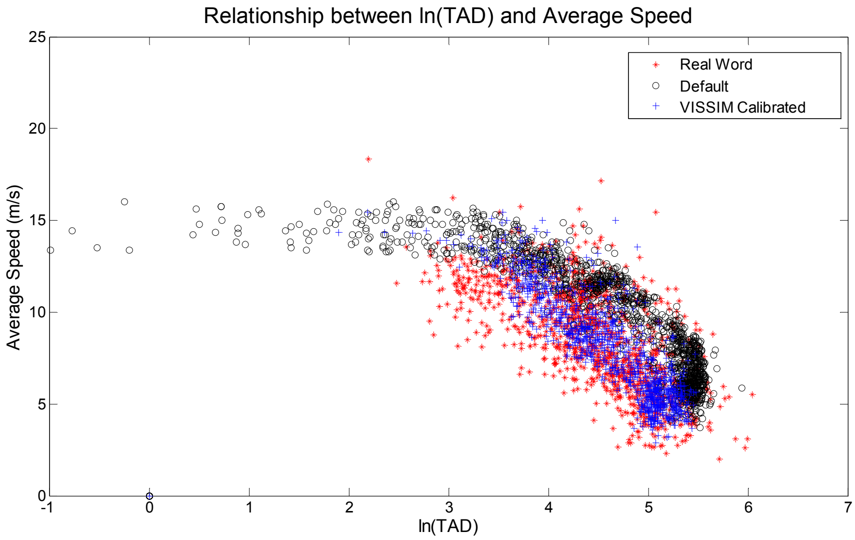

Figure 5: Comparison of *ln(TAD)* values

The application of the calibration significantly improves the accuracy of the emissions calculated with the microscopic simulation.

Conclusion

The calibration of parameters of a microscopic traffic model has to match the purpose of the application of the model. If the model is used for the estimation of emissions, the validity of the car following model has to be sufficient on the detailed level of speeds and accelerations. Trajectory data derived from remote sensing can be used to calibrate the simulation model in detail, which can insure the simulation program becoming valid tool for emission estimations.

References

PTV (2006) VISSIM 4.20 User Manual. Karlsruhe.

Keller M and de Haan P (2004). Emission factors for passenger cars and light-duty vehicles – Handbook Emission Factors for Road Transport (HBEFA) version 2.1. INFRAS, Bern.

Kim, S-J, W. Kim and L,R. Rillett (2005) Calibration of Micro-Simulation Models using Non-Parametric Statistical Techniques, 84th annual meeting Transportation Research Board, Washington DC.

Ossen S.J.L., Hoogendoorn S.P. (2007). Microscopic calibration method for estimating car-following models. TU-Delft Internal Report, Delft University of Technology.

Park B. , H. Qi (2005) Development And Evaluation Of Simulation Model Calibration Procedure, 84th annual meeting Transportation Research Board, Washington DC.

Wu, J., Brackstone, M. & McDonald, M. (2003) The validation of a microscopic simulation model: a methodological case study. Transportation Research Part C: Emerging Technologies, 11, 463 - 479.

Micro-Simulation Study of the Effect of Roadway Factors on Heterogeneous Traffic Flow on Intercity Roads

Shriniwas S. Arkatkar
Transportation Engineering Division, Department of Civil Engineering, IIT Madras, Chennai-600 036, Tamilnadu, India

V. Thamizh Arasan
Transportation Engineering Division, Department of Civil Engineering, IIT Madras, Chennai-600 036, Tamilnadu, India

Abstract

The information on traffic volume and capacity is an important input required for planning, analysis, design and operation of roadway systems. Roadway capacity is defined as the maximum sustainable flow rate at which vehicles or persons reasonably can be expected to traverse a point or uniform segment of a lane or roadway during a specified time period under given roadway, traffic, environmental, and control conditions; usually expressed as vehicles per hour. Roadway-capacity values used for planning, design and operation of highways, in most of the developed countries, pertain to fairly homogeneous traffic conditions comprising vehicles of more or less uniform static and dynamic characteristics. The road traffic in India is highly heterogeneous comprising vehicles of wide ranging physical dimensions, weight and dynamic characteristics. The different types of vehicles of the heterogeneous traffic on Indian roads may be grouped into the following categories: 1. Buses, 2. Trucks, 3. Light commercial vehicles comprising large vans and small trucks, 4. Cars including jeeps and small vans, 5. Motorised three-wheelers, which include three-wheeled motorised vehicles to carry passengers and three wheeled motorised vehicles to carry small quantities of goods, 6. Motorised two-wheelers, which include motorcycles, scooters and mopeds, 7. Bicycles, 8. Tricycles, to carry passengers or small quantities of goods and 9. Animal drawn vehicles. The speeds of these vehicles vary from just 5 to over 100 km/h. Due to the highly varying physical dimensions and speeds; it becomes difficult to make the vehicles to follow traffic lanes. Consequently, for manoeuvre, the vehicles tend to take any lateral position along the width of roadway, based on space availability. When such different types of vehicles with varying static and dynamic characteristics are allowed to mix and move on the same roadway facility, a variable set of longitudinal and transverse distribution of vehicles may be noticed from time to time. The interaction between moving vehicles under such heterogeneous traffic condition is highly complex. The problem of measuring volume of such heterogeneous traffic has been addressed by converting the different types of vehicles into equivalent passenger cars and expressing the volume in terms of Passenger Car Unit (PCU) per hour. The PCU is the universally adopted unit of measurement of traffic volume, derived by taking the passenger car as the ‘standard vehicle’. Thus, estimation of PCU values of vehicles is the pre-requisite for highway capacity and level of service analysis and to formulate effective traffic regulation and control measures.

Roadway capacity being the vital input required for road systems planning and operation, professional organizations in different countries have brought out guidelines for highway-capacity estimates for different categories of roads. The capacity estimates given in these manuals are all based on constant PCU values. Actually, however, the PCU value of a vehicle category may not be constant, because it may vary, based on, apart from vehicle factors, several other factors associated with the roadway, traffic and environmental conditions. Road width and magnitude of gradient are the important roadway factors that influence the vehicular movement and hence the vehicular interaction also significantly. Under heterogeneous traffic conditions, the increase in width of roadway invariably provides

relatively higher manouverability for all vehicle types, which may lead to change in the magnitude of vehicular interaction. The effect of upgrade and its length is also significant on traffic flow characteristics. On upgrades, heavy vehicles such as trucks and buses will experience significant reduction in their speed, whereas, passenger cars and other smaller vehicles such as motorized-two-wheelers and three wheelers may experience relatively lesser speed reduction. This variation in speed reduction among the different vehicle categories in heterogeneous traffic conditions can be attributed to their wide ranging physical characteristics such as dimensions, weight and dynamic characteristics such as engine power, acceleration rate, etc. Hence, it is also important to model the traffic flow on upgrades and study the change in traffic flow characteristics with change in magnitude of upgrade and its length. For accurate estimation of PCU values, it is necessary to study, at micro level, the influence of roadway and traffic characteristics by taking into account all the important influencing factors, on vehicular movement. Normally, solutions to such traffic problems are arrived at through empirical or analytical approaches. However, these methods have limitations and drawbacks particularly, while dealing with complex situations involving considerable amount of stochastic attributes. Also, study of traffic characteristics by observing various aspects of traffic flow in the field, is difficult and time consuming. Further, it is not possible to carry out such experiments in the field covering a wide range of traffic volume and composition on a given roadway due to practical difficulties. In view of this, simulation emerges as the most powerful, flexible and acceptable solution-searching tool.

As the present study pertains to the heterogeneous traffic conditions prevailing in India, the available traffic simulation models such as CORSIM, AIMSUN, VISSIM, MITSIM, etc., which are based on homogeneous traffic conditions, where clear lane and queue discipline exists, are not applicable to study the heterogeneous traffic flow characteristics. Hence, a simulation model of heterogeneous traffic flow, named, HETEROSIM, which was recently developed at the Transportation Engineering Division of IIT Madras, is used for this study. The model comprehensively addresses the stochastic and dynamic nature of heterogeneous traffic flow. The modeling framework is explained briefly here to provide the background for the study. For the purpose of simulation, the entire road space is considered as single unit and the vehicles are represented as rectangular blocks on the road space, the length and breadth of the blocks representing respectively, the overall length and the overall breadth of the vehicles. The front left corner of the rectangular block is taken as the reference point, and the longitudinal and lateral movements of vehicles on the road space are tracked based on the coordinates of the reference point with respect to an origin chosen at a convenient location on the space. The simulation model uses the interval scanning technique with fixed increment of time. For the purpose of simulation, the length of road stretch as well as the road width can be varied as per user specification. The model was implemented in *C++* programming language with modular software design. The simulation process consists of the following major sequential steps related to traffic flow: (1) vehicle generation, (2) vehicle placement, and (3) vehicle movement. The model is also capable of displaying the animation of simulated traffic movements. The inputs required for the model are: traffic volume, composition, free speeds of different types of vehicles, length of road stretch for simulation, width of roadway, overall dimensions (length and breadth) of different types of vehicles, acceleration and deceleration characteristics, total simulation period, etc. Any generated vehicle is placed at the beginning of the simulation stretch, based on the vehicle placement logic. During each scan interval, the positions of all the vehicles in the system are updated using the formulated movement logic. The movement logic includes the overtaking and car following manoevures as applicable to heterogeneous traffic. The model measures the speed maintained by each vehicle when it traverses a given reference length of roadway which is specified by the user, in addition to the various other flow characteristics of interest. The model has been applied for a wide range of traffic conditions (free flow to congested flow conditions) and has been found to replicate the field observed traffic flow to a satisfactory extent.

This paper is focused on studying the impact of change in road-width and traffic volume on traffic flow characteristics on intercity roads under the heterogeneous traffic conditions prevailing in India. This includes developing speed-volume relationships, estimation of PCU values of different categories of vehicles and hence developing capacity guidelines, based on the estimated PCU values, for intercity roads, in level terrain. Relationships between speed and length of gradient have also been developed for the different vehicle categories, under heterogeneous traffic conditions for road stretches having different gradients. These relationships are used for studying the variation in PCU values of the vehicles with change in the magnitude of gradient and also increase in the length of gradient. For this purpose, field data collected, by video capturing of the traffic flow on four-lane and six-lane divided roads in level terrain and on upgrades are used in calibration and validation of the simulation model. The validated simulation model is then used to derive Passenger Car Unit (PCU) values for different types of vehicles for a set of traffic volume levels falling over a wide range. The results of the study, provides an insight into the complexity of the vehicular interaction in heterogeneous traffic. It is found that, under heterogeneous traffic conditions, for a given roadway condition and traffic composition, the PCU value of vehicles vary significantly with change in traffic volume. Hence, it is desirable, to treat PCU as dynamic quantity instead of assigning fixed PCU values for the different vehicle categories. The PCU estimates, made through the microscopic simulation, for the different types of vehicles of heterogeneous traffic, for a wide range roadway conditions indicate that the PCU value of a vehicle significantly increase, with increase in width of roadway, magnitude of gradient and length of gradient. Finally, a check for the accuracy of the estimated PCU values is also made.

Microscopic simulation of car-to-infrastructure communication and online traffic state estimation
[Mikroskopische Simulation von Car-2-X Kommunikation und Online-Verkehrslageschätzung auf der Basis von FCD]

Arne Kesting
Institute for Transport & Economics, Technische Universität Dresden
Andreas-Schubert-Str. 23, 01062 Dresden (Germany)

Martin Treiber
Institute for Transport & Economics, Technische Universität Dresden
Andreas-Schubert-Str. 23, 01062 Dresden (Germany)

Abstract

Detailed and reliable online traffic state estimation is a prerequisite for advanced traffic information systems and the next generation of driver assistance systems. Besides the traditional data collection by stationary detectors, recent advances in wireless and sensor technologies have promoted new potentials for a vehicle-based data collection and local dissemination of information. As an application example of wireless infrastructure-to-vehicle communication, we consider the bidirectional exchange of data related to the local traffic situation: Probe vehicles collect “floating-car data” which are passed to “road-side units”. The floating car and other equipped vehicles, in turn, can receive processed and aggregated information about the current and predicted traffic state further downstream when passing such a road-side unit.

In our contribution, we study the problem of online estimation of the current traffic situation based solely on probe vehicle data. For this purpose, we study the data collection, the communication to road-side units and the traffic state estimation in-the-loop by means of microscopic traffic simulations. Given a certain equipment percentage, probe vehicles store their positions and speeds as functions of time and communicate this information to road-side units either by instantaneous forwarding by mobile phone communication, or, alternatively, by short-range communication when passing the location of a road-side unit. The road-side units are connected to each other and collect and process the data periodically in order to estimate the current average speed on the considered road section. The simulation-based approach enables us to compare the estimates of both communication modes to the - known and reproducible – traffic situation.

We place emphasis on the methods for the online traffic state estimation based on spatio-temporal speed data from probe vehicles. Our focus is on the estimation on the up- and downstream jam fronts determining the extension of traffic congestion. The proposed estimation method is based on the “adaptive smoothing method” which is a data processing method for obtaining continuous and smooth functions of space and time from discrete traffic data. The method has been developed for the offline reconstruction of traffic states on freeways from incomplete information and/or different data sources such as loop detectors and probe vehicles. It turns out that the method based solely on speed data is not sufficient for an online application if the percentage of probe vehicles is small (below 3%). For improvements, we therefore consider an additional heuristic for the extrapolation of jam fronts by a weighted linear regression. In contrast to detector-based measurements, it is not possible to measure the traffic flow by means of probe vehicles. Thus, it is interesting to compare the proposed method to a flow-based estimation approach requiring stationary detector data.

In a reference scenario, we simulate a section of a three-lane freeway with a flow-conserving bottleneck representing, e.g., a working zone. We use empirical detector data as upstream boundary condition and calibrate the simulation in order to reproduce the empirical situation. This reference scenario serves as starting point for the evaluation of the online traffic state estimation methods. We study the impact of delayed information transmission by short-range communication via wireless LAN in contrast to instantaneous information transmission to the road-side units by means of mobile radio (GSM). The delayed information transmission leads to systematic estimation errors which cannot be compensated for by a higher percentage of probe vehicles.

Result Assessment for User Acceptance and Safety Evaluation on Motorways with I2V-Communication

Thomas Richter
Technische Universität Berlin- Institute of Land and Sea Transport Systems
Sekr. TIB 3/3-3, Gustav-Meyer-Allee 25, 13355 Berlin, Germany

Philipp Gilka
Technische Universität Berlin- Institute of Land and Sea Transport Systems
Sekr. TIB 3/3-3, Gustav-Meyer-Allee 25, 13355 Berlin, Germany

Abstract

Initial Position

Beside the infrastructure extension, the traffic management is the main key to accomplishment the increasing traffic. The role of the infrastructure operator has changed during the last years. New task has to be established besides the key aspects of construction, operation and maintenance. Traffic information and traffic management belong therefore to the main functions. The management of the traffic flow consists of traffic control systems with their variable message signs (VMS). VMS are often used within the context of an Incident Warning System (IWS), with the purpose of warning drivers of any hazards along the road ahead. The expected effects are that road users reduce speed, increase headways and general alertness, and possible diversion to an alternative route. Present analysis regarding the benefit of traffic control systems show a reduction of accidents along equipped roads of about 30 percent (BAST 2001). Nevertheless, the effectiveness of VMS is highly dependent on user response to the displayed information and location of the VMS. A compounding factor is that, unlike an IVIS which can provide personalized routing information, VMS are constrained to display generic information. The goal of the EU-funded IP COOPERS (Co-operative systems for intelligent road safety) is to enhance road safety by direct and up to date traffic information communication between infrastructure and motorised vehicles (I2V) on a motorway section.

Overview

After the design of the system architecture, the definition of functions and the specification of the components as well as the development of the partial systems, the integration tests currently started.
The development of the COOPERS system is divided into road infrastructure components, car network components, a robust positioning unit and interfaces between infrastructure to vehicle. Demonstration of wireless safety services in all the dedicated demonstration sites will be the climax of the multi-year COOPERS project work. For that, demonstration planning has been a prominent task in the technical annex, respective description of work. The demonstration will take place on different sites in four corridors in Europe (Brennero, Rotterdam-Antwerp, Berlin city motorway and Lyon - Chamonix). The main task is to validate the effective co-operation of safety related road infrastructure systems and vehicles systems from a traffic management and user as well as a system perspective. On these sites the demonstration activities will be performed according to the experimental design. The research approach would be a classical before-and-after-analysis of a selected number of subjects (also regarding driving experience, age, and sex). This allows a direct comparison between both situations.

Research Agenda

In this COOPERS approach the tests grasp on different examination methods which covering the wide range of the hypothesis. The vehicle behaviour analysis provides a detailed view on the driver´s activities before and after receiving a service. All relevant vehicle parameter will be recorded during the tests. The driver observation approach allows aggregating the influence of traffic information of the driver behaviour. In the later section "Wiener Fahrprobe" a detailed consideration of this approach will be given. A second research approach to evaluate certain issues is the questionnaire. With this approach information about the user acceptance can be achieved. Furthermore the vehicle behaviour analysis and the driver observation method can be validated.

Analysing the driving behaviour can be reached in several ways, whereas currently two groups of methods have to be distinguished (Klebelsberg et. al. 1968):

- with the knowledge of the proband
- without the knowledge of the proband

The main goal of the analysis is to assess the impacts of the services on driver behaviour and user acceptance of the proband. Therefore the research approach follows the concept of comprehensive information of the volunteer drivers. Additionally this approach will be distinguished in literature between:

- Car following model (vehicle behaviour analysis) and
- Driver observation (driver behaviour)

With a special equipped probe vehicle of the TU Berlin it will be possible to measure the driving behaviour based on the vehicle kinematic parameters after receiving a COOPERS service. Exemplary measurements are:

- Lane change steering profiles
- Acceleration/Deceleration and speed profiles
- Longitudinal deviation during message perception
- Lateral deviation during message perception

The approach of analysing the driver behaviour would be carried out at defined sections and/or just when a message appears. This will be followed by an in-depth analysis of 10 sec in advanced and 30 sec after the incoming message is displayed. A comparison with the test drives without the COOPERS system at the same defined section would present tendencies of a driving behaviour but no significant conclusion. Due to the very small number of significant actual events which relate to the COOPERS services, such as speed limit warning or unexpected queuing which will happen during the tests, the data contribution to understand the impacts is probably very low. However, a focused approach based on analyses of the vehicle behaviour and the driver observation will provide latter two data sets which is more likely to yield understandings than exploratory analysis of the single data set.
Accordingly an observer approach is foreseen which is similar to the "Wiener Fahrprobe" (WFP). This approach allows aggregating the influence of traffic information of the driver behaviour. The WFP is a highly standardized approach through a defined driving route, with exact defined observation points.
An additional validation instrument of the vehicle parameter and the observational form would be the questionnaire and partly implemented interviews. That proceeding allows comprehensive approach with validated results.

Outlook

Finally a comprehensive assessment of safety and user behaviour and acceptance based on the demonstrators according to the comprehensive approach will lead to a common understanding according to the optimal level of information provision.
A detailed synopsis of the obtained results and the made experiences will bring findings of the impact of co-operative systems towards safety.