Advanced approaches to road safety evaluations

A. Calvi  F. D’Amico

Department of Engineering, Roma Tre University,
Via Vito Volterra 62, 00146, Rome, Italy
email: alessandro.calvi@uniroma3.it; fabrizio.damico@uniroma3.it

From 6th to 8th October 2015 more than 300 researchers attended the 5th International Conference on Road Safety and Simulation (RSS 2015) in Florida (USA), hosted by the University of Central Florida (UCF) and the University of Tennessee, Knoxville (UTK). According to the main core of RSS Conferences, the aim of the Conference was to create a common interdisciplinary arena for researchers and professionals involved in road safety, facilitate the exchange of know-how and progress in the last advanced techniques, methods and tools and their applications to safety analysis.

This Special Issue collects some of the researches presented at the Conference. It is organized in two Volumes, including nineteen papers that cover a wide range of research topics, provide a collection of new approaches and methods aimed at improving roads operation and safety and give an interesting overview of the current and innovative research in the fields of traffic behavior, road design, safety and operation, crash analysis and safety modeling. In fact, the papers of this Special Issue address several topics, from driving simulation to microsimulation, from road design and roadway modeling to the application of GIS tool for safety analysis, from crash analysis to safety modeling.

Specifically, in this Special Issue it is possible to realize how driving simulators are effectively used for 1) investigating the effects of road signage on driving performance in critical road area such as work zones, tool plazas and intersections; 2) evaluating the effectiveness of new in-vehicle systems or the driving behavior in automated vehicles; 3) analyzing driving behavior of distracted or impaired drivers; 4) studying environmental issues related to traffic emission once being equipped with calibrated and validated powertrain model.

Another important topic of research consists in the application of traffic microsimulation to road safety and operation issues. Specifically, in three papers of this Special Issues the microsimulation was used to study critical maneuvers such as left-turns in intersections and improve their safety and operation performances. Other authors used the same methodology for analyzing the safety of passing relief lanes and roundabouts while others developed behavioral models using both microsimulation and vehicle tracking through video processing.

As discussed above, road design is a crucial topic that can be studied with different approaches using several technologies and methods. Another paper presents a 3d-model for improving critical design standards such as those depending on the stopping sight distance.

Other interesting studies included in this Special Issue demonstrate the effectiveness of using GIS tool for safety analysis, developing safety models for predicting road crashed including weather and light conditions, and investigate driving behaviour and perception using subjective and objective measures.
A brief description of each papers published in Volume 1 and 2 of this Special Issue follows:

Evaluating traffic safety and performance effects of countdown timers on signalized intersections: a driving simulator study

Using a driving simulator van Haperen et al. developed a comparative analysis to evaluate traffic safety and performance effects of countdown timers on traffic lights of signalized intersections. The results show that the amount of stopping decisions increased when countdown timers were installed, indicating that improper early-stop ratios increased. Other findings are discussed in terms of accelerations, braking force and reaction times.

Operational and safety-based analysis of toll plaza signage using driving simulation

Valdés et al. developed a driving simulator study for assessing the effectiveness of different electronic toll collection lane types, and for investigating how signage and queues affect safety and driver behaviour and operations in toll plazas. The results of the study are expected to contribute both to the understanding of driving behaviour and to the operational safety features of toll managed facilities worldwide.

Virtual traffic signs - assessment of an alternative ADAS user interface with use of driving simulator

Mashko et al. study available approaches for assessment of in-vehicle navigation systems with visual display. Specifically, a system with an alternative representation of traffic signs on in-vehicle display aimed to help driver better orient at road sections loaded with information has been assessed during experiment on real car cockpit driver simulator. The results are encouraging as well as the need for further studies are discussed.

How does left lane width in motorway work zones affect driver behaviour and perception?

In their study Petzoldt et al. investigated the effect of left lane width on driver behaviour in motorway work zones. In a driving simulator experiment, participants had to drive on a motorway and passed through multiple work zones with different left lane width. Although driver’s willingness to overtake was not influenced by left lane width, results show that drivers perceived the differences in lane width, which increased their stress level, with some behavioural adaptation.

The effects of automation failure and secondary task on drivers’ ability to mitigate hazards in highly or semi-automated vehicles

Borowsky and Oron-Gilad used a driving simulator to understand how drivers would cope with manual driving in the case of automation failure. Specifically they investigate drivers’ ability to mitigate hazards in highly or semi-automated vehicles. Results show that while engagement with a non-driving related secondary task lead to more crashes, automation failure did not, especially when drivers were monitoring the road.

Impact of distracting activities and drivers’ cognitive failures on driving performance

In their driving simulator study Farah et al. investigated the impact of several distracting activities on driving performance. The findings revealed significant differences in the driving performance measures among drivers undertaking the various distracting activities, demonstrating that distracting activities negatively impact driving performance for both genders and all age groups, regardless of their experience in performing a second task while driving.

Which are the effects of driver distraction and brain pathologies on reaction time and accident risk?

Pavlou et al. analysed reaction time and accident probability of drivers with cognitive impairments due to various brain pathologies, in combination with in-vehicle distraction, through a driving simulator experiment, which was carried out by an interdisciplinary research team of neurologists, neuropsychologists
and transportation engineers. The results indicate significant differences between the driving performance of healthy drivers and patients as well as the mobile phone use has a significant negative effect on both reaction time and accident probability.

Parameterization procedure of a powertrain model for a driving simulator

In the work presented by Andersson et al. a powertrain model has been developed, parameterized and validated. The authors presented a methodology to parametrize the model for a test car using data obtained from non-invasive sensors, the chassis dynamometer and the pedal robot. The results of the powertrain model validation showed that in general the model is capable of simulating the response of the modelled powertrain with quite good accuracy at higher gears. For a driving simulator study at low speeds, where the usage of 1st and 2nd gears at lower engine speeds occurs frequently, the model should be improved.

Safety effects of freeway work zone delineation methods: response time as a surrogate measure

Xu et al. explored how various channelizing devices and layouts impacted a participant’s ability to correctly interpret a scene in terms of both response accuracy and response times of correct responses. Specifically, participants to the experiment were asked to identify freeway diverge locations under different work zone settings shown with computer rendered images. The results show that response times are closely correlated with other measures in indicating participant performance, although some differences exist.

Revision of left-turn guidelines using optimal design of traffic signal phasing in a microsimulation environment

Jolovic et al. analyse the optimal signal phasing designs using VISSIM microsimulation with the aim of improving efficiency and safety of the particular signal design in the field to test current recommendations and guidelines on left-turn treatments. The findings show that the current left-turn guidelines may over-protect left-turners resulting in reduced efficiency and left-turn delays, while revised guidelines should provide short delays for left turning vehicles, keeping high safety standards.

Left turn guidance based on crossing conflict analysis

Stamatiadis et al. propose a quantitative safety assessment tool able to predict left turn related conflicts as the deciding measure between different phasing schemes. The model was developed using VISSIM micro simulation software in conjunction with the Surrogate Safety Assessment Model. The authors discuss how the model shows predictive ability with correlation to left turn conflicts, but also include some limitations and highlight the need for future research to improve understanding of the left turn phasing implications.

Operational evaluation of partial crossover displaced left-turn (XDL) versus full XDL intersections

Abou-Senna and Radwan evaluate the overall intersection performance on the Crossover Displaced Left-turn intersections (XDL). The results highlight several important aspects regarding XDL traffic operations in the case of unbalanced volumes and demonstrate how partial XDL intersections can improve the overall intersection performance at various demands, reduce the costs associated with full XDL and prove to outperform the conventional intersection.

Safety assessment before and after implementation of roundabouts through microsimulation

In their study Roach et al. demonstrate the accuracy of the Surrogate Safety Assessment Model developed by the Federal Highway Administration in predicting potential number of conflicts at roundabouts that vary in their geometric design and traffic demand characteristics. Moreover, a before and after study is performed to assess safety benefits when signalized intersections and stop-sign controlled intersections are converted to roundabouts. The results show that under such conditions roundabouts significantly decrease the number of conflicts.
The assessment of road safety for passing relief lanes using microsimulation and traffic conflict analysis

Cafiso et al. investigated the safety performance of passing relief lanes using microsimulation and traffic conflict analysis. The authors proposed some models that provide a simple approach in determining the boundary conditions regarding safety to identify the minimum required length of a passing relief lane. Authors conclude that it is still necessary to continue collecting crash data and observed conflicts to assess the relationship between observed and simulated values of traffic conflicts.

Sensitivity of simulated vehicle tracking profiles for input into safety performance analysis

The research of Guido et al. consists in extracting experimentally from a videotaping the vehicle tracking profiles and comparing such profiles to the simulated ones for a given set of parameter inputs. The model was calibrated and validated for different traffic conditions. Results demonstrate how the input values suggested in the calibration stage can identify potentially unsafe vehicle interactions for vehicle movements based on car-following behaviour protocol.

Calculation of the available 3-d sight distance by modeling the roadway as a 3-d B-spline surface

Amiridis and Psarianos develop a mathematical methodology able to provide the sight distance calculation of a road directly in three-dimensional space and in a fully automatic and accurate manner. The authors show how in such a way the sight distance calculation, that is more reliable (since it is applied on a realistic three-dimensional road surface), could be made in each point of the road surface. Moreover, a great advantage of such methodology consists in the fact that it can be applied while designing the road.

A two-step geo-grid screening process to identify locations for safety improvements

Hancock et al. develop a two-step geo-grid screening procedure using a simple to use web-based GIS tool which enables anyone with access to crash data with the overall aim of quickly identifying high crash locations where viable safety measures could be applied, improving the return on investment for safety improvements. The results provide useful information to support resource allocation.

A case study to identify secondary crashes on Interstate Highways in Florida by using Geographic Information Systems (GIS)

Tian et al. used ArcGIS as the main tool to link the primary incidents and the secondary crashes within certain determined spatial-temporal criteria and proposed two filters to reduce the crashes that fail to meet the secondary crash assumption. The two filters selected the crashes that occurred in the same direction and downstream of the primary incidents. The ArcGIS based method was proved feasible and can be applied in various criteria based on specific traffic conditions and environments.

Understanding the factors affecting the frequency and severity of aging population-involved crashes in Florida

Omidvar et al. proposed a logistic regression crash prediction model that quantifies the impact of hourly traffic flow on the aging-involved crashes with respect to different weather and light conditions. The results demonstrated the adequacy and predictive capability of the fitted models with goodness of fit tests and cross-validation studies. The authors affirm that the proposed practical and easily applicable methodology can be incorporated into transportation safety plans.