

VIIS – VEHICLE INFRASTRUCTURE INTERACTION SIMULATION ON “REAL” ROADS

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ABSTRACT

The project VIIS (Vehicle Infrastructure Interaction Simulation), an actual research project which was started in January 2008 has the aim to build up on the MARVin (Model for Assessing Risks of Road Infrastructure; Paper of the 20th ESV) outcomes. The idea is to develop a combined simulation system, including all kinds of RoadSTAR data (Road Surface Tester of arsenal research; road condition and trace geometry) to verify crash causal combinations.

The MARVin software tool has been upgraded with traffic density data to get some more comparable and significant results. The crash causations regarding to poor surface characteristics or in-harmonic road geometry can be identified with a higher probability.

The main work is to integrate all relevant RoadSTAR parameters in a simulation software tool. In a beginning procedure a integration in the software PC Crash shows some positive results. The challenge will be to bring the skid resistance values as DXF data in a high density on the virtual route.

Virtual road sections can be designed with real measured data. Crash reconstructions and crash causal combinations (MARVin) are feasible. All kinds of vehicle dynamic data, which can be also logged in the CAN bus system, can be simulated and recalculated. The vehicle infrastructure interaction (road/tyre, suspension/tyre) in a crash situation leads to possible accident compensation measures like new in-vehicle sensors, innovative active safety systems, real time accident risk assessment, interactive road condition maps, etc..

The key point for the future of traffic safety issues are to verify MARVin results with vehicle-infrastructure simulations and to derive preventative measures either on the construction side or in the in-vehicle safety applications.

Visions are to combine theoretical accidentology with practical preventative solutions. Policy, vehicle manufacturer, road operators and map providers can have a benefit resulting from this research.

INTRODUCTION

As a step beyond “accident black spot” identification in road transport and traffic safety arsenal research developed a tool called *Model for Assessing Risks of Road Infrastructure (MARVin)*. The general objective is to link road infrastructure parameters with accident statistic data. Furthermore is MARVin a tool to assess and correlate road infrastructure parameters with road accidents (See Figure 1). More precisely, arsenal research uses the very detailed road database of the Austrian road network measured with the RoadSTAR (Road Surface Tester of Arsenal Research [1]). This database is associated with an accident data base, via the position of the accidents. In the accident database about 580.000 accidents are registered (1994 – 2007). As a result, the conjunction between the road database (approx. 24.500 km), with all relevant road infrastructure parameters (curvature, crossfall, skid resistance, texture, etc.) and the accident database was established. Any analysis with MARVin uses this combined database.



Figure 1. One of MARVin’s results projected on the real road: skid resistance vs. accident spots

SIMILARITY SEARCH USING DYNAMIC TIME WARPING

One of the most important developments and tools in MARVin is called similarity search, a patented method for the valuation of similar road segments. With this innovative technique the road safety

analyst is able to identify similar road sections in the road network. This is, however, not an easy task, as searching similar sections is not only finding an identical road stretch, but more looking for all parts that are like the sample. The task to identify similar road sections was solved by applying a computer-aided method which was originally developed for automatic speech recognition. The so called Dynamic Time Warping (DTW) [2, 3, 4 and 5] is a method which allows finding an optimal match between two given (multivariate) sequences (e.g. time series) with certain restrictions. In this case DTW yields a nonlinear similarity measure of different parameters with a given road section, the template.

With this development it is possible to analyse even a “virtual”, not yet built road section. A road in the design stage with a specific trace geometry and road condition-parameters can be analyzed by comparing it to already existing road sections (See Figure 2). This is a very important step to test planned and designed roads on their safety characteristics. Applying this method in the design phase will support the accident prevention significantly by identifying potential hazardous road risks before they are built.

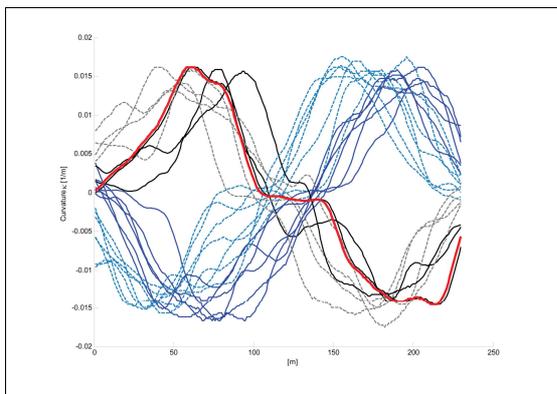


Figure 2. Graph showing result of the similarity search – example for curvature; red line shows the template

Another approach of MARVIN is to consider all accidents as objective as possible (“unbiased”). This is conceivable as the parameters of every accident are considered as discrete coordinates in a high-dimensional space. Correlations are perceived by different densities of the points (accidents) in this multi-dimensional space. Based on this approach, methods are developed to analyse the enormous amount of data. Computer-assisted solutions using statistical methods and/or data mining methods are proper tools for this task. Although the processing power to handle both accident database and road database in requires

remarkable computing power which should not be underestimated.

PRACTICAL WORK

The first practical work with MARVIN was a road safety check of a typical motorcycle route in Austria, to analyse correlations between the number of accidents on specific sites and the road infrastructure parameters. The interesting, but not surprising result was, that although the infrastructure quality of this road was very good (high skid resistance, perfect radii relations and curvature, etc.) the accident rate was rather high. The significant facts for the high risk potential of this road are the number of motorcyclists each day (especially at weekends) and the driven speed. Speed enforcement and awareness campaigns may lead to an accident reduction in this case. Moreover, MARVIN was useful to support the development of a national directive for motorcycle safety within a national framework. A detailed check of motorcycle accident events on rural roads and their correlation with curve radii revealed interesting results.

Specifically runoff accidents mostly occur in small radii between 50 and 150 meters; the maximum ratio of runoff accidents in curves is exactly for radii of 100m, followed by 110m and 200m. A detailed analysis on the relations between curve radii, curvature and changing crossfall and their influence on powered two wheelers (PTW) accidents is necessary. The “Similarity Search”, which identifies similar accident events on similar road sections, will also be helpful for this task and within further research projects.

VEHICLE INFRASTRUCTURE INTERACTION SIMULATION – VIIS

The main objective of a new research project: *Vehicle Infrastructure Interaction Simulation (VIIS)* is to model the interaction between vehicles and road infrastructure. In this sense the simulation will describe the effects and consequences of road parameters on vehicles in various driving situations. With this approach the simulation will use the findings and results of MARVIN to model the respective road sections based on all available road parameters (RoadSTAR Database). It is then possible to simulate and analyse the event of a specific accident. Due to the combination of infrastructure and vehicle models the spectrum of analyses is much wider.

Therefore MARVIN has been upgraded with traffic density data to obtain more significant results to be used in *VIIS*. With this approach the crash causations regarding poor surface characteristics or

in-harmonic road geometry will be identified with a higher reliability.

Road segments, to be used for simulation purpose, are designed in virtual reality but using the RoadSTAR DB with real measured data and a high sample rate (See Figure 3). Crash reconstructions and crash causal combination will be highly relevant with this. The vehicle infrastructure interaction (road/tyre, suspension/tyre) in a crash situation (or almost accident) have a major impact on the accident risk. New in-vehicle sensors, active safety systems, real time accident risk assessment, interactive road condition maps, etc. are developments to compensate that risk – and testing those developments in a virtual testing framework under realistic conditions will accelerate the process.

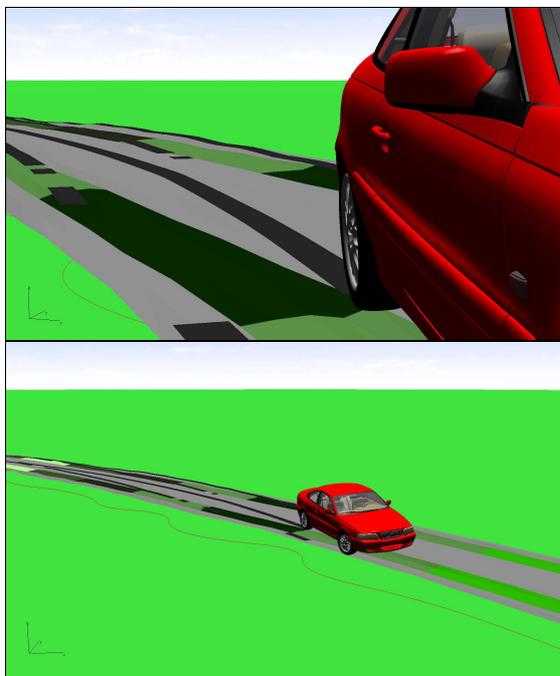


Figure 3. Two snapshot of VIIS results – skid resistance, rut depth and unevenness values used in virtual reality – causing a critical driving situation

VISIONS AND FUTURE

A vision for the future evolution of the proposed approaches and project results is to combine theoretical accident research with practical preventative solutions. It is most likely that policy, road operators, vehicle manufacturers, map providers and most of all the road users have a recognisable benefit resulting from this research.

The next step towards that vision is to verify MARVin results with an innovative vehicle-infrastructure simulation and to derive preventative measures either on the road construction side or in in-vehicle safety applications.

CONCLUSIONS

With the research project MARVin it is possible to identify significant correlations between road accident events and the quality of the road infrastructure. Various road parameters highly relevant for transport safety and an accident database are combined in this analysis. The road parameters are measured with the high-tech measurement vehicle the RoadSTAR on the Austrian road network. The research and development has already been useful to solve practical problems and analyses. Especially the development of the “Similarity Search” opens up new paths in crash-causes-research. The verification of crash-causal-combinations with an innovative simulation framework is an objective to improve the understanding of infrastructure-vehicle interaction during an accident. With this understanding a wide range of preventive measures to reduce accident risks are conceivable.

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