

Title: HIGH-RESOLUTION MODELING OF VEHICLE-PEDESTRIAN INTERACTIONS FOR ESTIMATING PEDESTRIAN RISK AT THE BLACK SPOTS

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Abstract:

The geo-referenced police data on the number of traffic accidents clearly point to "Black Spots", where the accident rate remains high in months and years. Road safety research, however, is still far from understanding why a certain place on a road is risky. Moreover, the very question of what constitutes a safe or unsafe road facility is yet under discussion (Gettman, Head, 2006).

The reason for a lack of consensus regarding road safety is the deficit of knowledge of how pedestrians and drivers interact when facing a potentially dangerous traffic situation (Zegeer, Sandt, 2006). In the same time, various aspects of pedestrian and driver behavior are investigated in laboratory experiments and field studies (Endsley, 1995; Klauer et al., 2006; Rensink et al., 1997; Schiff, Detwiler, 1979; Seward, 2007; Tresilian, 1995). The time came to combine this multi-facet knowledge within the spatially explicit agent-based model of the on-road vehicle-pedestrian interaction. Such a model enables estimating the influence of environmental and human factors and their interaction and provides the tool for assessment of safety measures, including changes in the Black-Spot geometry and architecture.

The paper presents the SAFEPED - microscopic 3D simulation of the Black Spot dynamics. The SAFEPAD simulator is build using Microsoft DirectX Technology (Figure 1) and its agents can behave autonomously, according to a predetermined set of rules or be guided by one or more human users. We consider SAFEPAD as a test platform for evaluating experimentally estimated drivers' and pedestrians' behavioral rules and employ it for estimating accident risks in different traffic scenarios.

SAFEPAD builds on externally constructed 3D environments (all industrial CAD formats are accepted). The user interface enables establishing agents' behavioral rules, interactive management of the model runs and scheduling agents' appearance and motion. When applied at an early stage of the planning and development process, SAFEPAD can reveal a disadvantageous design of the Black Spot and serve for assessing alternative architectural solutions (Archer, 2005).

The set of the behavioral rules of the SAFEPED agents – drivers and pedestrians – consist of two subsets. The subset describes the rules of agents' cognition and perception. The second subset describes the rules of agents' movement. The parameters of the cognition rules are established on the base of accident-related experimental data, including Time-To-Contact judgment, reaction time, driver inattention and pedestrian caution (Seward, 2007; Bonsalla et al., 2005; Bungum et al., 2005; Klauer et al., 2006). The parameters of motion rules include acceleration and deceleration rates, dependency of driving speed on curves on lateral acceleration, performance limitations for vehicles, estimated range of velocities, and acceleration and deceleration rates for different pedestrian modes - walking, jogging, and running (Bonsalla et al., 2005; TranSafety, 1998; Daniel, Fittanto, 2004).

Importantly, SAFEPED records all crash and near-crash episodes as well as the entire life-history of every agent during the simulation run thus enabling re-run of the simulation starting from any moment of time. In this way, the user can observe accidents from various viewpoints (including the viewpoints of the crash participants) and estimate accidents' characteristics. The replay mode enables intervening into the crash or near-crash dynamics by taking the full control

Jerusalem, Israel, May 30-June 2, 2010

over one or more agents.

The paper presents the implementations of the SAFEPED for verification and calibration of pedestrians' and drivers' behavioral models, and for estimating pedestrian risks at two Black Spot.