



Safety performance assessment of AEBV2X for car-to-VRUs collisions

¹*Kovaceva, J., ^{2,1}Flannagan, C., ³Schories, L.

*lead presenter

¹ jordanka.kovaceva@chalmers.se, Chalmers University of Technology, Sweden

² University of Michigan Transportation Research Institute, USA

³ ZF Friedrichshafen AG, Germany

Introduction

In Europe, cyclist fatalities remain high at 4.3 per million inhabitants. Almost half of all crashes involve vulnerable road users (VRUs), especially in urban areas, where crash rates are notably high. To enhance VRU safety, connected intelligent transport systems are being developed and introduced to the market. One such system, developed within the EU Horizon project “SAFE-UP”¹, is an autonomous emergency braking (AEB) system with vehicle-to-anything (V2X) communication. This system detects impending collisions with VRUs and autonomously applies brakes to prevent or reduce the severity of the collision. The aim of this study is to evaluate the effectiveness of the AEBV2X system in reducing fatalities and serious injuries among VRUs involved in car-to-VRU collisions on urban roads in the EU. This evaluation is conducted through prospective safety performance assessment using virtual simulations.

Method

In this study, the prospective safety system performance was evaluated using simulations, utilizing reconstructed crash scenarios involving collisions between cars and VRUs from the GIDAS² database. A comprehensive analysis of GIDAS crashes was conducted to identify relevant use cases for the AEBV2X system. Seven use cases were selected since they represent a majority of crashes in the database and are not yet fully addressed by the EuroNCAP protocols. Figure 1 shows these seven use cases. In these use cases, the reconstructed crashes from GIDAS-PCM data, were modified to include a baseline technology, which represents a camera-based perception AEB system, and a treatment technology, which represents AEB enhanced with an idealised V2X.

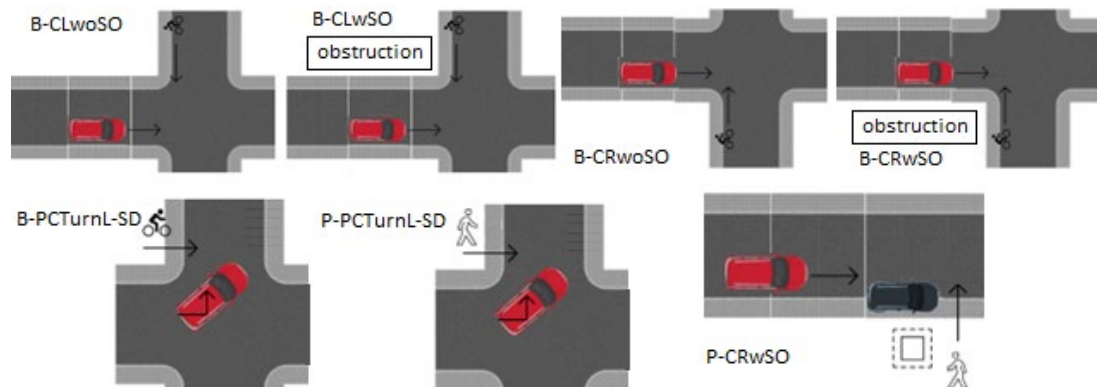


Figure 1: Assessed use cases in the safety performance assessment.

¹ <https://www.safe-up.eu/>

² <https://www.gidas.org/start-en.html>



Results

There were 2,710 unique crashes in GIDAS-PCM on urban roads that matched the use cases and had sufficient reconstructed information to support simulations. This data was used to quantify the effect of the system in Europe through extrapolation to European data in CARE³. Each case was used in the simulations for both baseline and treatment conditions. For each use case, the results for treatment are compared to those for the baseline, shown in Table 1. Results for the baseline system, relative to the current number of killed and seriously injured (KSI) and fatalities at the EU level are also reported in Table 1.

Table 1: Total count of KSI and fatalities for current EU in urban roads and avoided KSI and fatalities in baseline and treatment conditions per use case.

Fatalities	Use case	No system (N)	Baseline AEB avoided (N)	Treatment AEBV2X avoided (N)	Relative reduction rate AEB vs AEBV2X
	P-CRwSO	214	189	210	0.83
	P-PCTurnL-SD	47	47	47	0
	B-CRwSO	57	47	55	0.79
	B-CRwoSO	100	90	98	0.78
	B-CLwSO	32	25	30	0.74
	B-CLwoSO	69	59	66	0.66
	B-PCTurnL-SD	8	8	8	0.70
	Total	526	463	512	
KSI	Use case	No system (N)	Baseline AEB avoided (N)	Treatment AEBV2X avoided (N)	Relative reduction rate AEB vs AEBV2X
	P-CRwSO	3287	2779	3200	0.83
	P-PCTurnL-SD	718	718	718	0
	B-CRwSO	1502	1204	1438	0.79
	B-CRwoSO	2647	2337	2580	0.78
	B-CLwSO	837	652	787	0.73
	B-CLwoSO	1825	1505	1716	0.66
	B-PCTurnL-SD	217	208	214	0.69
	Total	11032	9402	10653	

Conclusions

The result from the virtual simulation shows the potential of AEBV2X system to further improve the safety of VRUs in the EU. The simulated V2X technology represents an ideal representation of the V2X communication. The relative reduction rate is up to 83% for the assessed use cases with sight obstruction, while in the use cases without sight obstruction the relative reduction is up to 78% compared to the baseline AEB system. In general, it can be noted that the baseline AEB system was able to prevent the majority of crashes already.

³ <https://shorturl.at/cmoOQ>