RSS2019 ROAD SAFETY & SIMULATION INTERNATIONAL CONFERENCE
Iowa City, Iowa, USA • 14-17 October, 2019
Transformations in Transportation

A review of the interactions between Autonomous Vehicles and Vulnerable Road Users

A. Ziakopoulos[1], T. Rosenbloom[2], D. Pavlou[1], G. Yannis[1]
[1]National Technical University of Athens, *apziak@central.ntua.gr
[2]Management Department, BIU

THE UNIVERSITY OF IOWA
THE NATIONAL ADVANCED DRIVING SIMULATOR

Summary

- Recent technological advancements have led to **a race in Autonomous Vehicle (AV) developments**.
- One of the issues that is most critical when considering the circulation driverless AVs in roads is their **interaction with Vulnerable Road Users (VRUs)**.

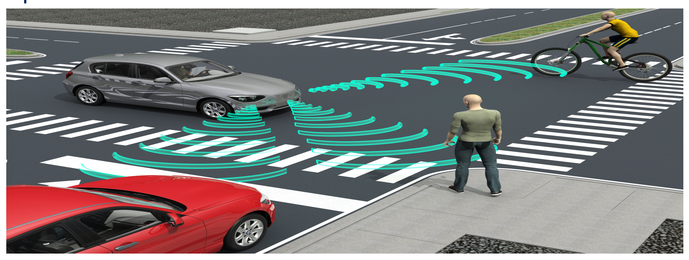
The present research is a review study aiming to investigate the issues of interaction between AVs and VRUs.

- A literature review from recently published studies worldwide was conducted for **assessing** the available technologies and **locating** possible future trends.
- 2 investigated sides:
  - the **side of AVs** and automation technology overall,
  - the **VRU side**, such as trust and acceptance.
- Research Question:
  - How **different levels of automation** will affect the interaction between AVs and VRUs?
- **Major limitations of AVs** include accurate navigation, efficiency and reliability issues, as well as the absence of a robust legal framework; lack of social acceptance is a factor as well.
- **VRUs are not yet critical** in present frameworks of HMI (human-machine interaction), which are rather based on social norms that have been established with human drivers controlling the vehicles.
- Thus the interactions of AVs are **a justified source of skepticism and hinder the onset of AVs**.
- On the other hand, if VRUs have the knowledge that AVs are more safely operated, this **would lead to improved confidence** and overall quality of life.
- Past research has shown pedestrians to be at fault in 80% of pedestrian crashes at intersections, which demonstrates the **need to safeguard them** despite any possible improper behaviour on their part.
- It appears **very challenging to predict behavioral intentions of pedestrians and cyclists** by current technology.

Study characteristics			Investigated side		Data used			Parameters examined	
Author(s)	Year	Country	AV	VRU	Field data	Simulated data/ Questionnaire	No data	VRU recognition / warning from AV	AV trust/ acceptance from VRU
Bandyopadhyay et al.	2013	Singapore	●		●	●		●	●
Banks et al.	2014	United Kingdom	●				●	●	
Brar & Caulfield	2017	Ireland		●		●			●
Christie et al.	2015	Switzerland		●	●				●
Clamann et al.	2017	United States		●	●				
Dehais et al.	2012	France		●	●			●	
Habibovic et al.	2016	Sweden		●	●				●
Katrakazas et al.	2015	United Kingdom	●						
Krotosky & Trivedi	2007	United States	●		●			●	
Liu & Khattak	2016	United States	●		●			●	
Millard-Ball	2016	United States		●			●		●
Palmeiro et al.	2018	Netherlands		●	●				●
Rosen	2013	Sweden	●			●		●	
Rothenbucher et al.	2016	United States		●	●			●	

Conclusions

- Low-level (2 or less) automation-ADAS technologies **provide positive impacts on road safety**
- In automation levels of 3 or higher, there is still **a lot of uncertainty** when trying to predict AV-VRU interactions from the present state of affairs
- The exact handling and overall AV performance under different conditions such as weather, road class, lighting, traffic conditions etc. will **be dependent on their programming**.
- VRU-AV interaction can happen independently of all these conditions and several **different outcomes** will be observed, at least during the initial phase of full automation.
- There exist considerable knowledge gaps and **lack of analyses** of some of the existing VRU categories (road users with mobility impairments).
- It is obvious that from a road safety perspective, there can be **no hard evidence** until AVs roll out of the factory and operate on real-world conditions.



- There are **hard bets to be won**, as any malfunction against VRUs will generate negative outlook to the public which will be disproportionately high compared to crashes between conventional vehicles and VRUs.
- Research on the detection of **mobility-impaired VRUs** such as manual or electric-powered wheelchair users seems to be lacking.

Acknowledgement

The present research was carried out within the research project "***LEVITATE - Societal Level Impacts of Connected and Automated Vehicles***", which has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824361.