

Invited Paper: Safety Assistance Systems for Bicyclists: Toward Empirical Studies of the Dooring Problem

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The Dooring Problem

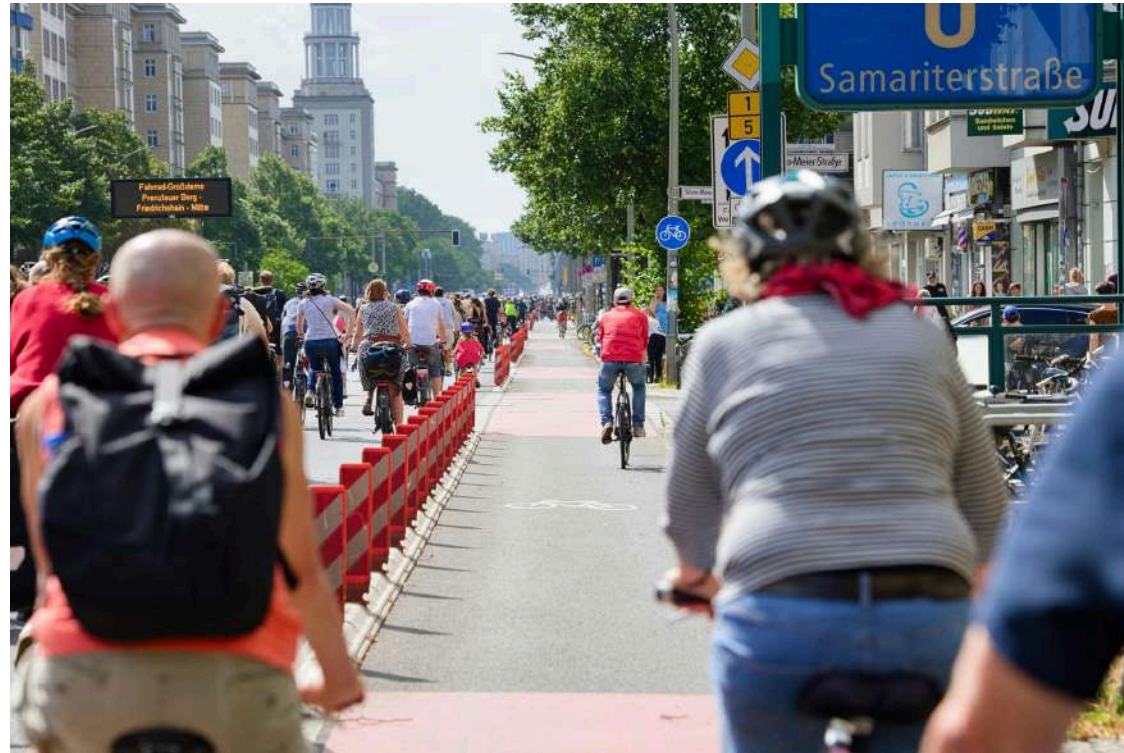
- Car door opened in the way of a cyclist
- Car occupants should pay attention
- Cyclists should keep distance



Dooring Prevention: Infrastructure



Dooring Prevention: Infrastructure




Dooring Prevention: Dutch Reach



1. <https://www.forbes.com/sites/carltonreid/2018/10/17/dutch-reach-car-door-opening-technique-added-to-britains-road-rules/>

Dooring Prevention: Advanced (Driver) Assistance Systems

Audi Technology Portal


DE | EN



Drivetrain
Electrics/Electronics
Chassis
Body
Mobility for the future


Controls
Driver assistant systems
Lighting technology
Multimedia
Safety Systems

Audi A4 exit warning





The exit warning is activated when the new Audi A4 and Avant stop moving. If other vehicles are approaching from behind, it warns occupants as they open the doors. The system warns drivers by means of LED fiber optics in the inside door-opening mechanism (contour lighting). In situations that are assessed as dangerous, special high-performance red LEDs blink and light up. The exit warning stays on for approximately three minutes after the ignition is turned off.

Status: 09/2015



Audi A4 exit warning

1. <https://www.audi-technology-portal.de/en/electrics-electronics/driver-assistant-systems/audi-a4-exit-warning-en>

Assistance Systems – Current Limitations

254 Driving and parking

System limits

Blind Spot Assist and Active Blind Spot Assist may be limited in the following situations, in particular:

- If there is dirt on the sensors or the sensors are obscured
- In poor visibility, e.g. due to fog, heavy rain or snow
- If there are narrow vehicles, e.g. bicycles or motorbikes
- If the road has very wide or narrow lanes
- If vehicles are not driving in the middle of their lane

Warnings may be issued in error when driving close to crash barriers or similar continuous lane borders. Always make sure that there is sufficient distance to the side for other traffic or obstacles.


Warnings may be interrupted when driving alongside long vehicles, for example trucks, for a prolonged time.

Blind Spot Assist and Active Blind Spot Assist are not operational when reverse gear is engaged.

Additionally, the exit warning may be limited in the following situations:

- When the sensors are covered by adjacent vehicles in narrow parking spaces
- When people approach the vehicle
- In the event of stationary or slowly moving objects

Function of the brake application of Active Blind Spot Assist

 The brake application function is only available for vehicles with a Driving Assistance Package.

If Active Blind Spot Assist detects a risk of a side impact in the monitoring range, a course-correcting brake application is carried out. This is designed to help you avoid a collision.

The course-correcting brake application is available in the speed range between approximately 20 mph (30 km/h) and 125 mph (200 km/h).

WARNING Risk of accident despite brake application of Active Blind Spot Assist

A course-correcting brake application cannot always prevent a collision.

- ▶ Always steer, brake or accelerate yourself, especially if Active Blind Spot Assist warns you or makes a course-correcting brake application.
- ▶ Always maintain a safe distance at the sides.

WARNING Risk of accident despite Active Blind Spot Assist

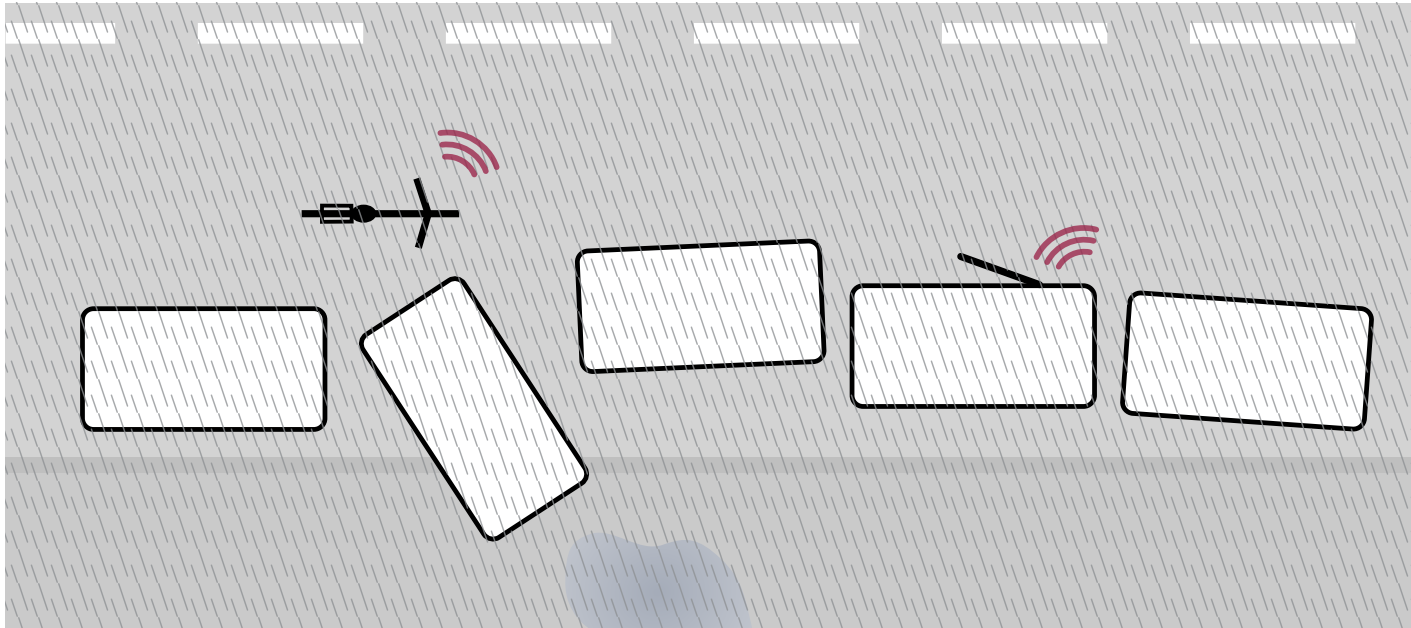
Active Blind Spot Assist does not react in the following situations:

- If you overtake vehicles at a high speed.
- If vehicles approach and overtake you at a greatly different speed.

Active Blind Spot Assist may not give warnings or intervene in such situations.

1. <https://www.mbusa.com/content/dam/mb-nafta/us/owners/manuals/2022/OperatorManuals/EQS%20Owners%20Manual.pdf>

V2X Communication



Distributed Assistance Systems

Where to do demanding computations?

Example: Trajectory prediction

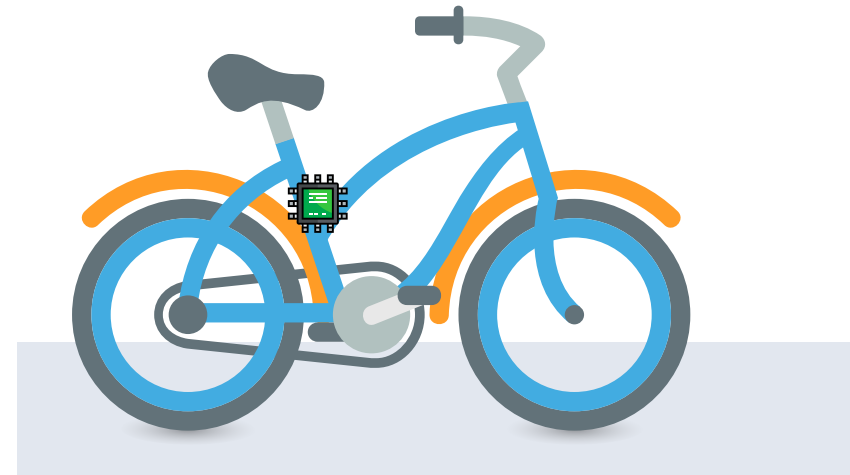


Elements from [svgrepo.com](https://www.svgrepo.com)

Distributed Assistance Systems

Where to do demanding computations?

- Integrated bicycle computer?



Elements from [svgrepo.com](https://www.svgrepo.com)

Distributed Assistance Systems

Where to do demanding computations?

- Integrated bicycle computer?
- Smartphone?



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Distributed Assistance Systems

Where to do demanding computations?

- Integrated bicycle computer?
- Smartphone?
- Cloud?

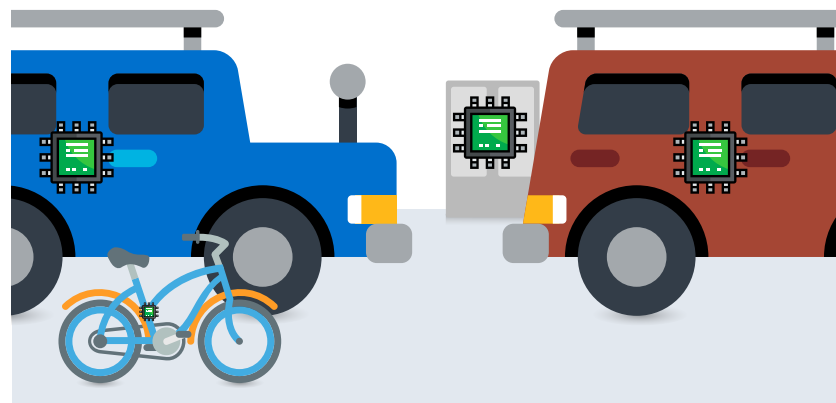


Elements from svgrepo.com

Distributed Assistance Systems

Where to do demanding computations?

- Integrated bicycle computer?
- Smartphone?
- Cloud?
- Distributed in local environment?



Elements from svgrepo.com

Human-in-the-Loop Experiments – A Virtual Cycling Environment¹

- Coupling of
 - Traffic simulation (SUMO)
 - Network simulation (Veins/OMNeT++)
 - 3D Environment
 - Bicycle on a training stand



1. [1] J. Heinovski, L. Stratmann, D. S. Buse, F. Klingler, M. Franke, M.-C. H. Oczko, C. Sommer, I. Scharlau, and F. Dressler, "Modeling Cycling Behavior to Improve Bicyclists' Safety at Intersections – A Networking Perspective," in *IEEE WoWMoM 2019*, Washington, D.C.: IEEE, Jun. 2019. doi: [10.1109/WoWMoM.2019.8793008](https://doi.org/10.1109/WoWMoM.2019.8793008). Documentation: <https://vce.readthedocs.io>

Human-in-the-Loop Experiments – A Virtual Cycling Environment¹

- Coupling of
 - Traffic simulation (SUMO)
 - Network simulation (Veins/OMNeT++)
 - 3D Environment
 - Bicycle on a training stand
- No risk of traffic accidents



1. [1] J. Heinovski, L. Stratmann, D. S. Buse, F. Klingler, M. Franke, M.-C. H. Oczko, C. Sommer, I. Scharlau, and F. Dressler, "Modeling Cycling Behavior to Improve Bicyclists' Safety at Intersections – A Networking Perspective," in *IEEE WoWMoM 2019*, Washington, D.C.: IEEE, Jun. 2019. doi: [10.1109/WoWMoM.2019.8793008](https://doi.org/10.1109/WoWMoM.2019.8793008).
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Extension of the VCE



Conclusion

- Distributed assistance systems could prevent many traffic injuries (e.g., dooring)
- We show how such systems can be studied safely with humans in the loop
- Further research is needed:
 - Effective assistance systems
 - Distributed mobile sensing and computing

Thank You!



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Evaluating Dooring Assistance Systems in the VCE

