HMIs promoting safe AV-cyclist interactions

Siri Hegna Berge
Department of Transport & Planning, Delft University of Technology, Netherlands
SHAPE-IT ESR 10

SHAPE-IT

Human-machine interfaces (HMIs) have the potential to aid cyclists in future traffic with automated vehicles (AVs).

How can HMIs assist cyclists with AVs, and what are the implications of using HMIs to be safe in automated traffic?

BACKGROUND

Interaction with cyclists in complex urban traffic environments poses a major challenge for AVs.

Two proposed solutions:
1. On-vehicle interfaces providing additional communication cues through displays, lights, or projections on the road
2. Equipping vulnerable road users with awareness and notification systems

We have investigated these two solutions and their implications for cyclists in three studies. The overall goal is to improve the safety of cyclists in future traffic through development, testing, and evaluation of interface design strategies.

INTERVIEW STUDY

- Interaction of cyclists and AVs was explored among Norwegian and Dutch cyclists.
- Cyclists prefer to be segregated in traffic with AVs, and in mixed urban traffic, they need confirmation of detection by AVs.
- External on-vehicle or on-bike HMIs might be solutions to fulfil the cyclists' need for recognition.
- Cyclists are hesitant about on-bike HMIs, mainly due to unclear utility value and the ethical aspect of imposing the responsibility of safety on the more vulnerable road user.

CYCLIST SUPPORT SYSTEMS

Cyclist wearables 36 concepts
AR glasses (13)   Smartphone (11)   Helmet (11)
Other (5)   Head-up display (4)   Beacon (4)

On-bike devices 35 concepts
Handlebars (22)   Mounted display (9)   Unspecified (6)
Head-up display (5)   Frame (4)   Rear (5)   Seat (4)

Vehicle systems 30 concepts
Side (7)   Hood (6)   Roof (5)   Windshield (5)
Bumper (3)   All around (2)   Rear (1)   Unspecified (10)

Infrastructural systems 21 concepts
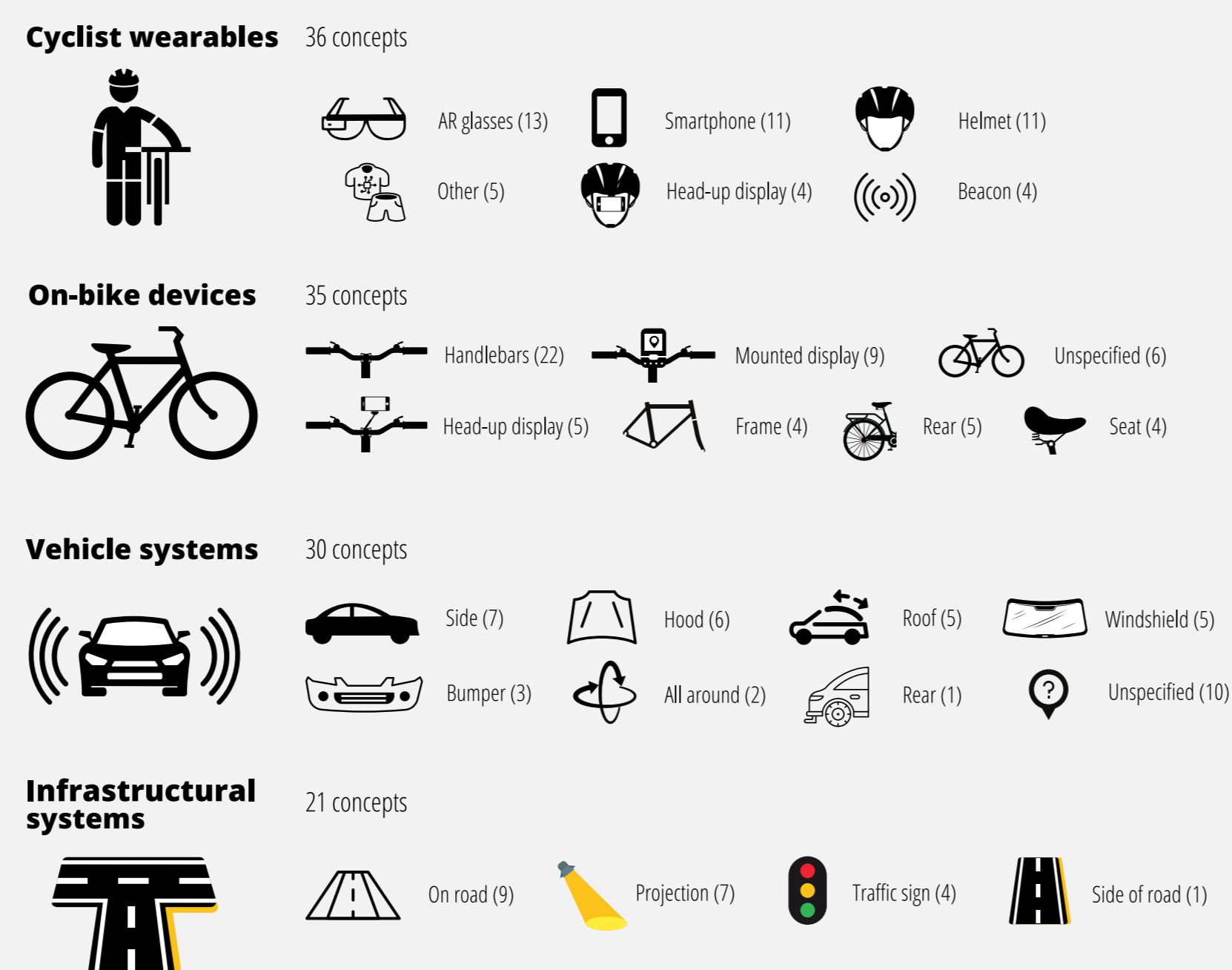On road (9)   Projection (7)   Traffic sign (4)   Side of road (1)

Figure 1. The placement of cyclist support systems (n=92)

- A synthesis of the future outlook of systems supporting cyclists in traffic with automated vehicles.
- The physical, communicational, and functional attributes of 92 systems were analysed (see Figure 1 and 2).
- We suggest that on-vehicle systems should have visibility all around the vehicle and incorporate two-way communication.
- Cyclist support systems should be explored in complex and representative scenarios with automated vehicles.
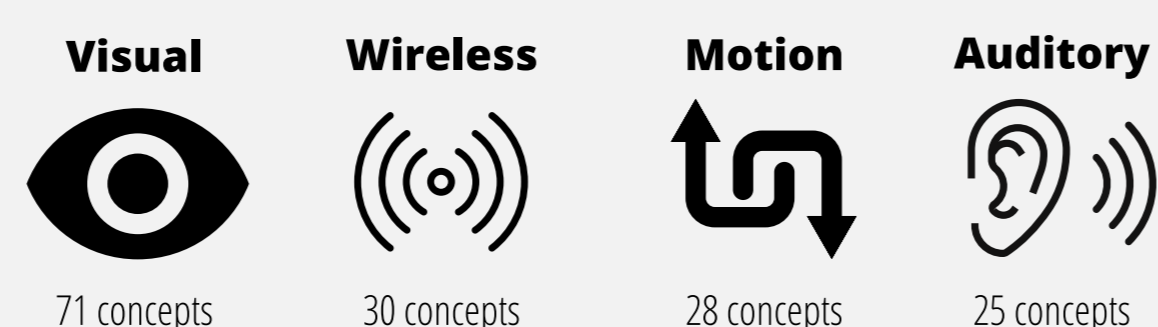
Visual 71 concepts   **Wireless** 30 concepts   **Motion** 28 concepts   **Auditory** 25 concepts

Figure 2. The mode of communication of cyclist support systems (n=92)

AV-CYCLIST SCENARIOS
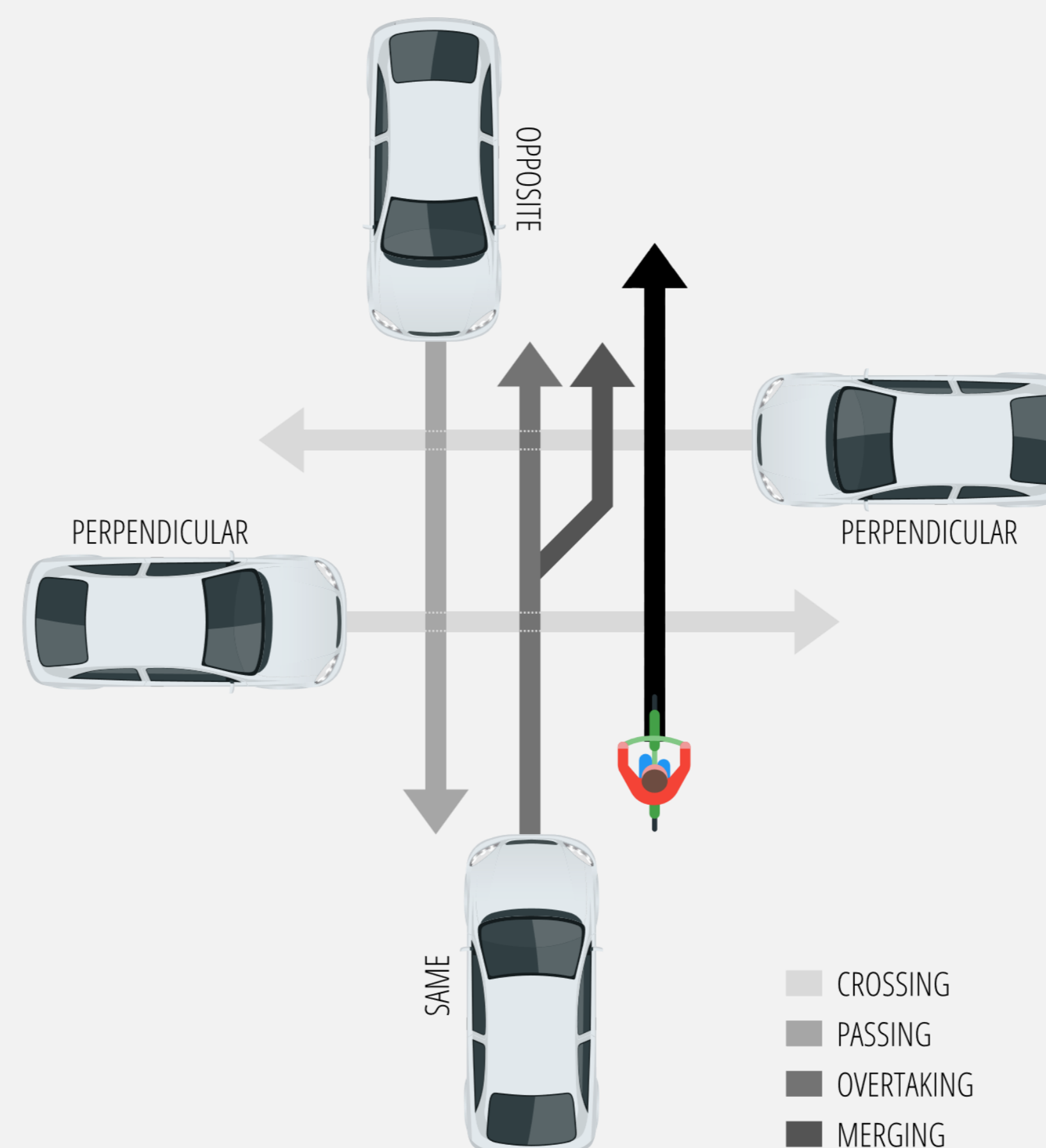

CROSSING
PASSING
OVERTAKING
MERGING

Figure 3. The four scenario groups and direction of movement

We developed test scenarios of AV-cyclist interaction.

Triangulation of data
1. A systematic literature review of previous research on AVs and cyclists
2. A review of in-depth reports of cyclist accidents with vehicles
3. Group interviews with traffic safety and automation experts

Twenty scenarios were identified and categorised into four groups: Crossing, passing, takeover, and merging scenarios (see Figure 3).

PUBLICATIONS

Berge, S. H., Hagenzieker, M., Farah, H., & de Winter, J. (2022). Do cyclists need HMIs in future automated traffic? An interview study. *Transportation research part F: traffic psychology and behaviour*, *84*, 33-52.

Berge, S. H., de Winter, J. & Hagenzieker, M. (2022). Support systems for cyclists in automated traffic: A review and future outlook. *Preprint on ResearchGate.*

SUPERVISION & CONTACT

Supervisors
Prof.dr. Marjan Hagenzieker (TU Delft)
Dr.ir. Joost de Winter (TU Delft)

✉ s.h.berge@tudelft.nl
in in/sirihegnaberge
RG profile/Siri-Berge

ACKNOWLEDGEMENTS