The Manipulation of pedestrian-automated vehicle interaction : A Scoping Review of experimental methods

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Introduction

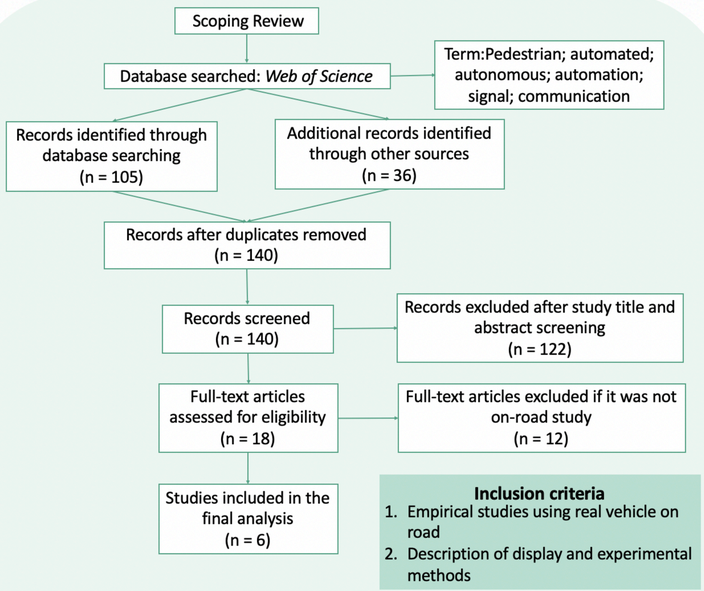
- One of the major challenges that autonomous cars are facing today is driving in urban environments.

- Autonomous vehicles need the ability to communicate with other road users, especially pedestrians, about their intention.

Objective

- This project aims to provide an overview of **the experimental methods to study pedestrian-vehicle interaction** in the context of autonomous driving.

Methods

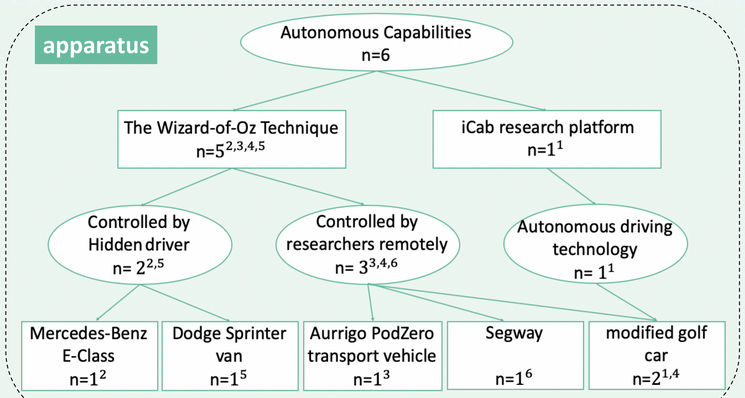


- **Flow diagram and search strategy** using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) model.

Results

1.How to realize intelligent communication with pedestrians?

- Most of the reviewed literature utilized the Wizard-of-Oz technique : The researcher controlled the vehicle and its different interface cues.
- Only one literature utilized iCab to allow autonomous behavior and detection of obstacles.



2.What anticipation shall be established through instruction and scenarios?

- **Instruction**

Basic description of fully automated driving	The meaning of different interaction display	the autonomous driving technology
-Only one article[2] introduced the definition of fully automated driving. -Some others[1,5] measured driver's attitude towards automated driving systems.	-Four articles[2,4,5,6] provided the meanings of different displays in advance. -One article[3] only told participants their tasks. -One article[1] didn't tell anything In order to gain the first insights.	-Only one article[4] explained the technology on the car.

- **Scenario**

parking lot	intersection	straight path	crosswalk	corridor
Four articles[2,3,4,6]	One article[2]	One article[1]	One article[5]	One article[6]

- Most of the articles conducted experiments in parking lots.

3.How to conduct an experiment?

task		measurement
Subjective measures (question-aire)	Pre-study	demographic information[5,6], crossing behavior[5],perceptions about autonomous vehicles[5], personality[5]
	In-study	confidence[6], deeper insights about the display[2,6]
	After-study	familiarity[1],crossing behavior[1], understood the awareness and intent of the display[1,4,6], trust[2,3,4], perceived safety[2], user experience[2], perceived intelligence[2,3], transparency[2], acceptance[3]
behavioral tasks (recorded by video)		-response type[1,4] (positive/negative/hesitate) -response time: crossing/clearing onset/duration[2,4] , duration felt happy/safe[3],decision time[5] -distance from the car[4] -count of crossing decisions[6]
structured/ semi-structured interview		deeper insights about the display[2,6], whether understood display[5], strategies[5]

- Five articles[2,3,4,5,6] ask participants to cross an intersection/road or step aside, one article[1] did not have any task.

Discussion

- **The Wizard-of-oz Technique is a good method** for safety if the automation technology is still undeveloped.
- **Scenarios like intersection or parking lot are recommended** since they are common traffic situations that require vehicle-pedestrian interaction.
- Future studies can further explore **whether the meaning of display could be understood directly without instruction or has to be learned as a convention.**

If you have any additional questions or comments, please contact Xin Yin at: xye3@ncsu.edu.

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Pedestrian-Vehicle Communication Displays in the Context of Autonomous Driving: A Scoping Review

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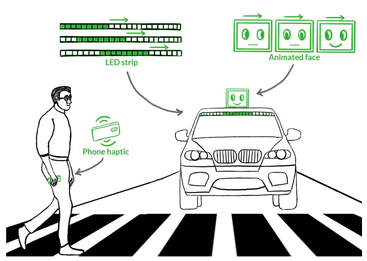
Background and Objective

1. Background

- One of the major challenges that autonomous vehicles are facing today is the interaction with pedestrians.
- Designers of autonomous vehicle technologies have proposed multiple types of displays, including LED lights, screen and voice instructions to communicate with pedestrians.



2. Objective

- This project aims to provide an overview of the pedestrian-vehicle communication displays in the context of autonomous driving.

Method

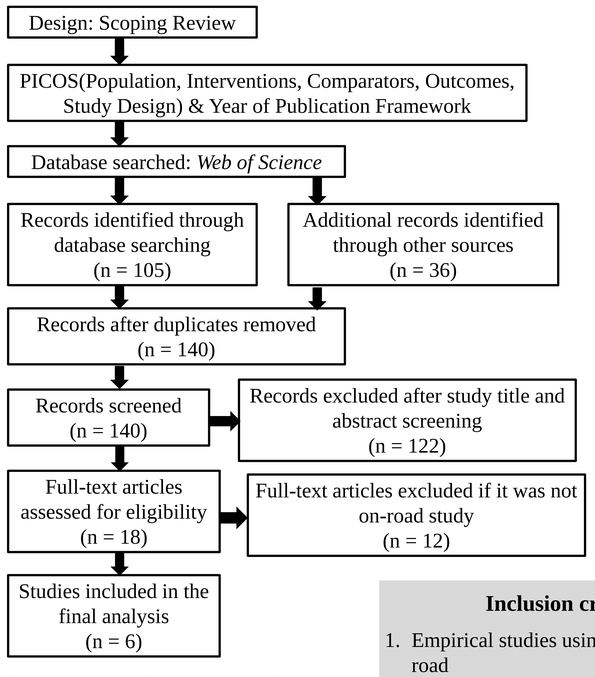


Figure 1. Flow diagram of scoping review

Inclusion criteria

1. Empirical studies using real vehicle on road
2. Description of display and experimental methods

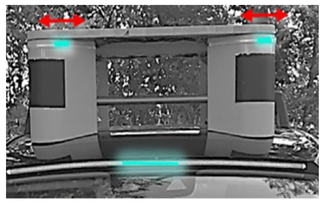
Results

1. What communication displays were tested in these studies?

TABLE 1. Classification of the communication displays in these studies

Studies	Displays			Information					Interface
	Visual	Auditory	Haptic	Status	Perception	Intention	Advice	Speed	
Faas et al., 2020	√			√	√	√			• LED light strips
de Miguel, 2019	√				√		√		• Images(eyes & colors) showed on a screen
Mahadevan, 2018	√	√	√		√	√	√		• An LED strip • a speaker • LED lights • a screen (eyes) • an Android phone
Clamann, 2017	√						√	√	• A LCD screen
Matthews, 2017	√	√			√		√		• LED word display • Speakers • strobe light
Burns, 2019	√					√		√	• Projectors • LED light strips

TABLE 2. Illustration of some visual displays

Interfaces	Images	Details
LED light strips (Faas et al., 2020)		• Steady lights: status • Flash and move along the strips : perception • Slow flash: yield • Fast flash: plan to go
A screen (Clamann, 2017)		• A dynamic display indicating when it was safe or not to cross • A dynamic display presenting the speed of the vehicle
A projector (Burns, 2019)		• Projected striped lines indicating intention • “bunch” together: slow or stop • Expand away: accelerate • Flex to right or left: turn a corner • A large blue arrow: the position to turn

3. The effectiveness of these displays

- Generally, any kind of communication displays support the interaction.[1, 2, 3, 5] But, vehicle motion patterns such as speed and distance are still the most crucial cues.[3, 4, 5, 6]
- Visual display is the primary way for communication. Auditory cues may be cacophony in the real world.[3]
- Intention information is more helpful supplementary information than perception information.[1, 3]
- The effectiveness oaf anthropomorphic cue especially the eye gaze still remains uncertain.[2, 3]

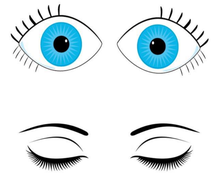


Figure 3. the eye gaze showed on a screen

Recommendations

- Among the 6 studies, only 2 used auditory display and 1 used haptic display. More forms of displays should be included and tested in the future.
- Designers should consider diverse pedestrian populations, such as elderly people and people with color blindness.
- It’s important to find a balance between informing and information overload.

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