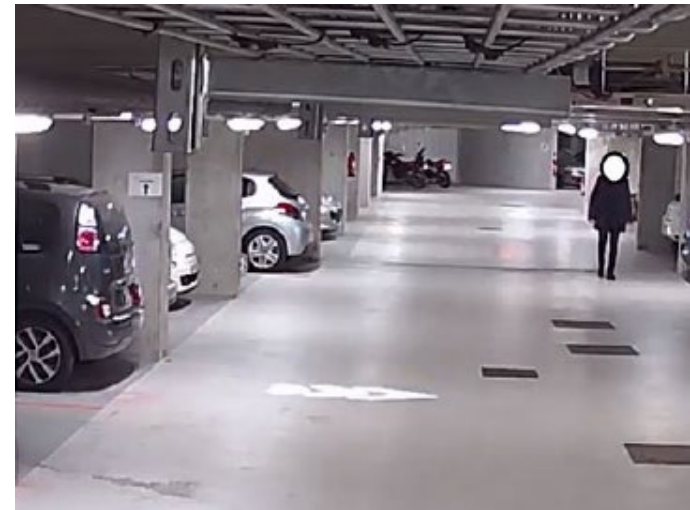


“Signalling Road Projection” (SRP) Status report & Request for guidance

87th GRE session

25-28 October 2022



Signalling Road Projection Introduction

- In Fall 2021, GTB initially introduced the idea for Signalling Road Projection (SRP) to GRE and presented informal document GRE-85-38. *Note: the context is limited to projections combined with turn indicators and/or reversing lamps.*

- GTB experts are convinced that SRP is contributing to road safety as it allows also vulnerable road users to recognize driver's intentions on intuitive basis.
 - Scientific evidence has already been proven for reversing projection and further scientific research has been initiated for direction indicator projection.
 - A draft text for Signalling Road Projection is under preparation by the experts.

- GTB is asking for guidance to GRE about how to implement SRP into the existing UN Regulations.

Signalling Road Projection Content

Introduction

a) Scientific research

- I. Direction indicator projection – ongoing studies
 - Yeungnam University
 - ELS
- II. Reversing projection – scientific evidence of benefit for Traffic Safety
 - Impact of Advanced Lighting Function based on Road Projection for Departing Indication in Parking Lots, S. Azouigui, ELS, ISAL 2019

b) Guidance needed from GRE

c) Timeline for a draft proposal to amend UN Regulations Nos. 148 and 48

Signalling Road Projection

Scientific research – Direction indicator projection (Yeungnam)

Pre-study: VR-based driver monitoring and scenario evaluation

- Shape of projections
- Different angles and scenarios of projection
- Checked data: behavioural and subjective

Step 1: Virtual Simulator-Based Finding of Benefits and Potential Distraction

Step 2: Validation based on Mock-up Lamp for Critical Situation

Final results expected for last quarter of 2022

Signalling Road Projection

Scientific research – Direction indicator projection (ELS)

Objective of the study:

Safety relevance of DI SRP

- Use-case: Intention of departing from a parallel parking space
- Tests on cyclists and in urban situation
- Three scenarios (no signal, turn indicator only, turn indicator + SRP)

Final results expected for last quarter of 2022

Signalling Road Projection

Scientific research – Evidence for benefit of Reversing projection (ELS)

Impact of Advanced Lighting Function based on Road Projection for Departing Indication in Parking Lots, S. Azouigui et. al., ELS, ISAL 2019

Road Projection

Impact of Advanced Lighting Function based on Road Projection for Departing Indication in Parking Lots

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Keywords: road projection, light communication, departing, parking lot, safety

1. Abstract

This paper presents a study commissioned by GTB (Groupement de Travail de Recherche), aiming to investigate on the safety aspect of a new function using light projection on the road, as a new mode of communication with road users. Such promising function will add another dimension and it should be assessed, regarding the lighting technology. It should provide additional safety by communicating relevant information. Within this scope, a study was conducted at ILS, in collaboration with KIT, to evaluate the impact of road projections for departing indication in a parking lot. For this purpose, more than 2000 cars were captured and on participants' driving behavior, reaction and perception were studied using parking spaces. The participants were subjected to the departing indication of a car, which was intended to behave more intuitively with a green beam. The test were designed to allow an evaluation whether the proposed idea is well perceived, understood, and acceptable by the different road users. This paper will first describe the intended study, measure methods, description, selected behaviors, an objective to identify driving errors and behavior of the light projection, as well as a questionnaire to assess the acceptability of the function, usability, understanding, perceived effectiveness of the sign and perceived ability, intention to use. Results and conclusions are given in the following work function can further enhance awareness regarding a departing indication in parking lots.

2. Introduction

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Road Projection

Road projection, i.e. light signal projected on the road, offers the great possibility to design a new mode of communication between the car and other road users, besides the already existing light communication between the automobile industry (AV) and its customers [1]. Lighting functions using road projection could bring awareness and important information to dedicated communication of AV's with vulnerable road users [2], and they could come first to the notice of AV's themselves, such as lighting functions for road users themselves and their behavior and their safety impact have still to be investigated [3]. In particular, advanced and clear interpretation of the light message have to be assessed, first for safety issues but also for a successful and harmonized application of such new lighting systems [4][5]. Among these lighting functions, the departing indication, i.e. the light signal projected on the road to indicate that a car is heading out from its space, is devoted to the city-dwelling [1][6][7] and is subject to various safety issues of the parking situation and then to have a relevant added value, especially in parking lots, where other road users (like drivers and cyclists) (pedestrians and scooters), when assessing the number of available spaces of a higher utilization possibility [8]. To anticipate the safety issues of the departing indication in parking lots, a study was conducted at ILS, in collaboration with 4 scientific domains of Technology, and conducted by GTB [9]. This work aims to evaluate the impact of such road projection and to determine whether such signal is lighting indication delivers a relevant message and influences safety, understandability of the lighting technology. For this purpose, data were more collected and covered with 27 participants (22 tested as drivers, 5 as cyclists and 0 as pedestrians) in an underground parking garage. This paper will first describe the intended study and protocol, followed, the test setup will be described. The results of the study will be presented and, finally, conclusions on the safety impact of such road projection will be given.

3. Designed tests and protocol

Designed tests

The field tests were designed as a controlled experiment in a well-known parking lot. The study was carried out by comparison of the light projection in the field and a control form of backing signaling, i.e. reverse light, as they are placed within rather low beam level. To avoid possible bias due to learning effect of the car position, tests were performed using two cars (driver car 1 and driver car 2) and indicating the departing with reverse light and light projection and the other with reverse light only. Both cars

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Road Projection

were parked into the parking lot in circles in Figure 1 and a similar colored distribution in parked cars around them was indicated during the whole test. A backward situation with reduced visibility of the departing car from the subject's coming angle (seen from behind by a hidden camera), was created as departing configuration, to better measure the effect of the road projection. The departing indication was triggered at a given position (1, 2, 3 or 4) from the center car using colored beams. The proposed light signal (white color, 1 Hz flashing, size of 1.1 x 0.8 m, distribution of 1000 lux) was displayed in the back of the car using beamlets, installed in the driver city (reverse lighting, 100 lux) (see Figure 2).

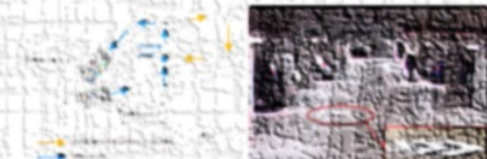


Figure 1: Parking lot, participants and proposed signal.

Figure 2: Light projection on the road.

Effectiveness, however, was evaluated by the following dimensions could be measured: detection and perception of the signal, understanding of the message carried by the signal, safety during search for signal, detection and safety behavior and acceptability. For this purpose, three main assessment methods were used:

- Objective measurements using cameras to record critical events around the driver's car, camera inside the driver's car (like car driver's direct reaction points) to record the participant's direct experience, driving data (CAN recorded)
- An objective evaluation and analysis of the participants' behavior and hazard response, with an objective effect on the tests
- A subjective assessment with a questionnaire administered after the experiment

Test protocol

Tests were designed so that the participants could be subjected to three different scenarios A, an inverse light, an road projection, scenario B, departing indication with reverse light, and scenario C, departing indication with reverse light and road projection. Each participant was subjected twice to the tests, in order to evaluate the

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tests were conducted, 10% understood the new lighting function in the proposed signal, compared with 10% with reverse light. For better understanding, it was designed to add the proposed signal to the car.

Stress and safety feeling

The tests were designed to avoid stress when activating the reverse lighting during the driver's car "backward" and "unintentional" situation as shown in Figure 3 in the contrary, results related to their comprehension, fear and anxiety are less important, even though. Furthermore, the average safety feeling is slightly positive, regardless the driver of different behaviors, driver users slightly better rated their feeling than pedestrians and cyclists. Further analysis shows that safety feeling is better rated by drivers because already used the function (as pedestrians) than by other drivers. This may be due to the fact that drivers' understanding the signal as a second car was aware amount of possible distributions of the situation, because they had more to understand the lighting situation in their own cars (as pedestrians), but also, to the fact that the driver of the car did not feel stress enough to be in contact of the sight of the signal. Conversely, as their behavior, the drivers did not realize the danger of the situation because they did not drive the backing car or because they did not feel signal on a full (100% of 4 driver users). All participants considered reverse safety feeling was negatively rated, it is directly linked to the fact that the participants did not have time to react (as drivers) so that they had no sense of possible distributions of the situation by means of the proposed signal. This is indeed reflected by the fact that they assessed the signal "negative" rather "intuitive" to represent their feeling.




Figure 3: Safety feeling using a scale and results from the Multiple choice of assessment

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Signalling Road Projection

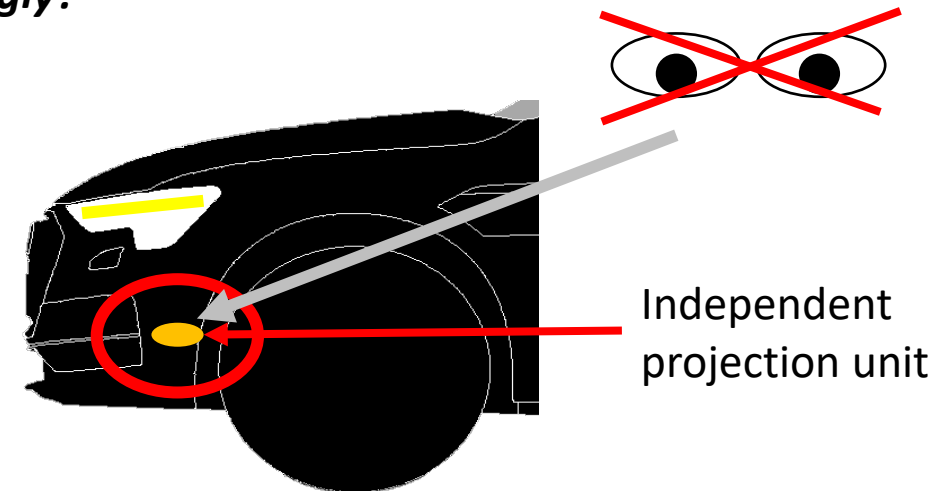
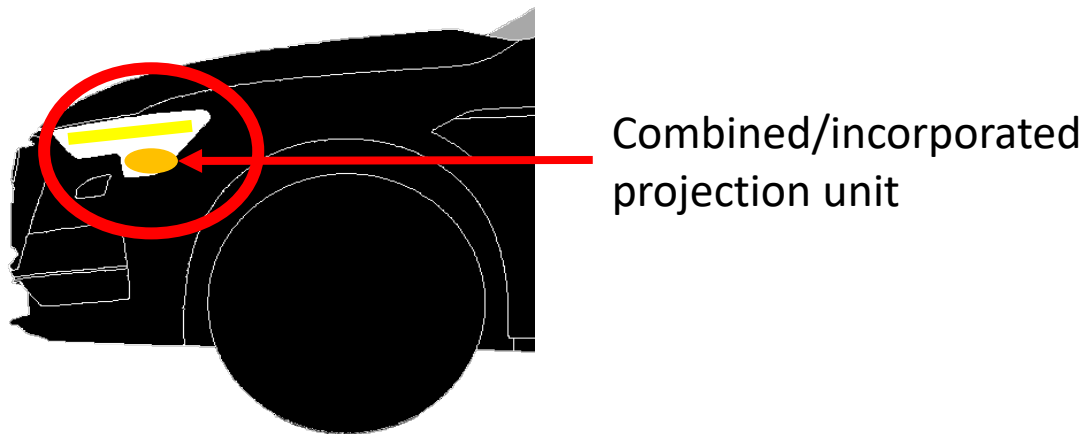
GRE guidance needed – implementation approach

GTB identified a benefit in allowing the Signalling Road Projection being either combined or independent of the signalling function. GTB also sees a benefit for harmonization of the UN and Chinese regulations on signalling projection.

The draft Chinese standard defines “signalling projection units” that may be independent from, or combined/reciprocally incorporated with, other light signalling devices.

In case of independent devices, they shall not be visible to other road users*.

→ Does GRE agree to amend the UN Regulation(s) accordingly?



* Note: Non-visibility criterion already exists in R48 for courtesy/manoeuvring lamps and can be applied for projection modules as well

Signalling Road Projection

Timeline for Signalling Road Projections

Draft proposal for UN Regulations Nos. 148 / 48

- *GRE-87*: Intermediate information and open questions
- *GRE-88*: Informal draft proposal
If possible, a Live Demonstration of vehicles with Signalling Road Projection will be organised
- *GRE-89*: Formal proposal, taking into account the input received during GRE-87 and GRE-88, including justification and information about the studies