'Across Safely' – Perception based Communication for V2P

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Abstract

Communication and interactivity are a key factor between vehicle and pedestrian, which cause that pedestrian may feel unsafe when it is not been communicated within driver of vehicle. Application range of front ligting functions for communication V2P is improved further, and vehicle bumpers are been strategic attractive position for the integration of automotive exterior lighting functions such as displays, LED based module which enable V2P communication. Many concept designs and case studies are featuring bumper of vehicle with exterior module have been relized.

This proposed paper will give application instance of communication with vehicle to pedestrian (V2P) on the road within two different kinds of illumination scenarios which includes lighting structure on the bumper, sensor intelligence and data flow on the vehicle.

Keywords: Automotive Lighting, Communication Pedestrian to Vehicle, Multi-pixel Systems

1 Introduction

In the last years, studies to V2P communication featured rigid automotive exterior displays or road projection scenarios. Free form surfaces on the other hand are key in an OEM's design language and demand solutions which support design freedom and V2P communication. Flexible OLED displays have been commercially available since 2019, but fail to reach luminance and automotive requirements yet. Liquid crystal displays (LCDs) on the other hand are ready for high luminance applications, but their flexible counterparts are still stuck in research. Up to now, no investigation has been done using video projection systems to illuminate automotive bumper surfaces in order to enable V2P communication. Projections on free form surfaces differ from typical road projection applications and come along with a new set of challenges: distortion correction via raytracing with regards to the ob-server's position. Additionally, typical projection challenges apply, e.g. high illuminance for V2P communication in daylight [2]. Drivers can safely interact with the environment and communicate its intention to all road users, including the driver. Well-known symbols are crosswalks for pedestrians, arrows to mark and highlight danger spots and the ideal further path as guidance for the driver [3].

The presented work introduces an pattern reflecting which enables functionalities based on bumperlight. As todays headlight and bumperlight systems are mainly focused on ordinary driving tasks such as lighting the frontal vehicle scene. By means of the presented reflecting pattern method, features can be determined from multi pixel light distribution in order to tailor the given approach to series application, a more sophisticated pattern projection is considered, aiming on embedded lighting module.

2 How the system works

Sensor and detection system are integrated in the interior rear view structure as well are connected to front window of the vehicle that the sensor is detecting pedestrian walk signboard on the road, which is illustrated as a instance in Fig. 1. and related scenario in Fig. 2.

Highly automated vehicles use a variety of sensors to detect objects surrounding the ve-hicle for planning the safest route to be taken. The sensors mainly include RADAR, LI-DAR and cameras as well as additional sensors such as microphones to detect acoustic signals in traffic. All sensors have their advantages and disadvantages, for example RA-DAR has a low resolution, but this sensor provides not only the distance but also the relative speed of other road users. LIDAR has a higher resolution but has problems in bad weather conditions like heavy rain or fog. Cameras offer the highest resolution and additional color information, but they have, comparable to the human eye, problems in poor light and weather conditions. Compared to RADAR and LIDAR, the big advantage of cameras is the low

cost of the sensors and the generation of relatively high resolution images for traffic control and contrast calculation. A prerequisite for safe autonomous driving is that each sensor is optimized for this purpose and provides sufficiently good data quality for the subsequent detector and planning algorithms [4].

Fig. 1. Sensor and detection system [5]

After detect pedestrian on the road, detection signal and data is sent to the drive which is run simultaneously within ECU for processing what kind of the action will be implemented.
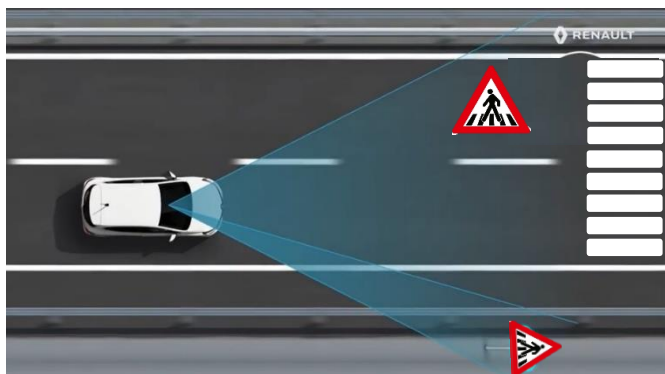

Fig. 2. Detection scenario [5]

Pattern of the pedestrian walk signboard is reflect the dashboard of the vehicle for warning to driver which is illustrated in Fig. 3. Besides, It is possible that function of the detection system can be activated and deactived according to driver preference via touchscreen or button of steering wheel which is illustrated in Fig. 4 and Fig. 5 respectively. Activation guide;

- While the vehicle is stopped and reach to "vehicle section" on the dashboard, press ♦ to button.

- Press to ▲ or ▼ buttons for reaching to "settings menu" and press "**OK**" button.

- Press to ▲ or ▼ buttons for reaching to "drive support" and press "**OK**" button.

- Press to ▲ or ▼ buttons for reaching to "pedestrian walk signboard warning function" and press "**OK**" button.

- Pres to "**OK**" button for activate and deactivate to function

Fig. 3. Reflect of pedestrian walk signboard on the dashboard [5]

Fig. 4. Function preference on the dashboard [5]

Fig. 5. Function preference on the steering wheel

A module is integrated and activated on the front bumper of the vehicle that module includes pixel LED and programmable individually from each other in order to create related pattern on the surface when pedestrian walk signboard is detected through sensor as well. It is designed two different kinds of pattern in order to ensure communication with pedestrian on the road which specifications are specified in Table 1.

Table 1. Pattern Specifications

Pattern Code	Statement	Colour
A.P.G	Pedestrian will be across, vehicle will be stop	Green
S.P.R	Pedestrian will be stop, vehicle will be across	Red

It is used pixel LED which specification is RGB, and occured PCB based lighting module which is enable that LED's can be run dynamicly.

The scope of communication between vehicle to pedestrian, while the vehicle is driven on the road and approach to pedestrian walkway, and if there are any pedestrian who intend to across, it is used warning illumination system on the front bumper of the vehicle for which side how will behave on the road.

Scenario 1:

While the vehicle is driven on the road, and if there is a pedestrian walk signboard, it is detected through sensor and reflect warning on the dashboard. If driver intend to stop while approaching to pedestrian walkway, driver press " 🚶 " button on the steering wheel by hand as a manual function.

After the press related button, it is reflected "green coloured pedestrian icon and A.P.G pattern code" which state to pedestrian that the vehicle will stop while arrive to pedestrian walkway, and pedestrian can across comfortable without any suspect, it is illustrated in Fig. 6.

Fig. 6. A.P.G Pattern

Scenario 2:

While the vehicle is driven on the road, and if there is a pedestrian walk signboard, it is detected through sensor and reflect warning on the dashboard. If driver does not stop while approaching to pedestrian walkway due to high speed or any kind of the unusual circumstance, driver press " 🚶 " button on the steering wheel by hand as a manual function.

After the press related button, it is reflected "red coloured pedestrian icon and S.P.R pattern code" which state to pedestrian that the vehicle will be driven while arrive to pedestrian walkway, and pedestrian should not across, it is illustrated in Fig. 7

Fig. 7. S.P.R Pattern

3 Summary and Outlook

Communication between vehicle to pedestrian (V2P) is necessary in order to ensure guarantee traffic flow without any kind of accident as well unclear situations and signalization. When it is compared accidents ratios of pedestrians with other objects, pedestrians are most vulnerable road users, rely on explicit communication with driver of vehicle to feel safe and make sure as well assuring the driver's attention.

The study enables that lighting applications on the vehicle in order to ensuring communication with pedestrian as well bicyclist and any kind of objects on the road, are implemented for future vehicle generation as well reduce accident ratios which caused by pedestrian and other kind of objects, and contribute to improve mobility and digitalization.

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