Additional Safety through Headlight Projections

Until now, only head-up displays have been used to superimpose necessary information onto the driver's field of vision in such a way that the driver does not have to take his eyes off the road. Ford has modified the headlight system so that information on navigation and traffic is projected directly onto the road.

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Particularly when driving in the dark, it is important to keep the driver's attention and gaze as far away as possible from what is happening in front of the vehicle and the course of the road, due to the limited visibility compared with driving in daylight. Thanks to steering headlamp systems or, more recently, predictive steering and thus directional headlamps, the center of the light beam is always on the road ahead of the vehicle. It now makes sense to supplement the light, which is optimally positioned on the vehicle's path, with additional information, thus making the journey as effortless as possible for the driver.

HEADLIGHT PROJECTION

The new LED headlight system could take this a step further. In addition to the conventional low beam and high beam, it has a pixel module that can display 30,000 pixels in a 100 × 300 matrix. The benefits include both a much improved and more accurate glare-free high beam – as well as the opportunity to project warnings and information using a wide variety of symbols, graphics, or even dynamic film clips. Currently, the module can be tilted vertically to be active either in the high beam area or in the apron area. In this way, a greatly improved and more accurate glare-free high beam or, tilted downwards, corresponding projections with various information can be realized in the apron.

The display of graphics requires additional effort to the conventional LED headlamp, since image sequences must be both processed and transmitted. Until now, control was limited to a given light distribution. which, for example, was partially switched off for glare-free high beam. The number of channels that have to be controlled in the pixel headlight has multiplied, and the representations have become more complex. The interfaces must be adapted to this amount of data.

INFORMATION OVERLOAD

With modern vehicles, the amount of information a driver is provided with has increased dramatically. In the early days, this was easily displayed on the instrument cluster behind the steering wheel. This is easily visible with only a small angular deflection of the eyes, so that the driver can easily implement the motto "Eyes on the road, hands on the wheel". The information was limited to the content necessary for driving a vehicle, such as speed, rpm, warning and status displays and the like.

The radio, or today multimedia devices and similar equipment, multiply the amount of information offered and it is up to the driver to pay attention to it depending on its relevance.

With the display arrangements common today and the abundance of information, among other things for navigation, the time spent looking and searching for the relevant displays is relevant. In the 1 to 2 s necessary for this, one covers up to 50 m at speeds common on country roads. Thus, any possibility of making the information relevant to the driving task directly accessible to the driver without him having to take his eyes off the road is helpful. Thus, a display and localization that minimizes or even eliminates this time of inattention is preferable.

LOCATION-CORRECT DISPLAY OF DRIVING-RELEVANT INFORMATION

Until now, the only way to support this has been to superimpose necessary information into the driver's field of vision with a head-up display without requiring the driver to take his or her eyes off the road. The information floats above the road ahead, only seemingly creating the impression that the information is in the path of travel. With the latest headlamp technology, it is now possible to write information directly onto the road.

PROJECTION HEADLIGHTS

LED technology basically allows great freedom in the design of the headlamp. There are virtually no limits here in terms of shape and size. Further development of LED with stronger and more efficient chips has opened up the possibility of glare-free high beams after replacing the conventional low beam and high beam function with horizontal segmentation of the high beam, or matrix high beam; Further development now leads to the pixel headlamp. With sufficiently high resolution both horizontally and vertically, symbols and images can now be displayed in their entirety.

REPRESENTATIONS

By adjusting the pixel module vertically, pictograms can be projected onto the road ahead of the vehicle. These can be warnings detected by the vehicle's sensor system, such as warnings of ice or slippery snow, **FIGURE 1**. Another possibility would be turn-by-turn directions from the navigation system, **FIGURE 2**, or indications of traffic signs recorded by the vehicle's camera. Speed limits are currently probably the most frequently perceived signs from the vehicle with the usual display in the instrument cluster. Displaying them on the road in front of the automobile keeps the driver's eyes on the road and the information constantly present, **FIGURE 3**.

To make it easier for the driver to keep in lane, two lines projected parallel on the road according to the width of the vehicle can be highlighted in front of the vehicle following the curvature of the road. The benefits to the driver will be greater the more predictive the data is about the curve ahead of the vehicle. This can be done via the line detection of the vehicle camera or via a highly accurate ADAS map with extensive attributes and use of the Electronic Horizon system, **FIGURE 4**.

With the knowledge of the exact position of the vehicle and the upcoming route, further helpful information supporting the driver can be displayed. Examples include a warning of a very curvy section of road or the approach to a roundabout, **FIGURE 5** and **FIGURE 6**.

FIGURE 1 Ice and snow warning (© Ford)

FIGURE 2 Turn-by-turn directions from the navigation system can be displayed in good time (© Ford)

FIGURE 3 Never drive too fast again thanks to speed limit display (© Ford)

DISTRACTION BY THE REPRESENTATION

The fundamental question regarding the possibilities offered by a pixel headlight is: "What should be displayed?" Signs and information should be intuitive and easy to see. Due to the limitation that the spotlight only emits white light, there are also limits to what can be displayed. Pictograms are a good choice for quick and easy perception. These meet all the requirements for the necessary unambiguous comprehensibility.

With all the assistance provided to a driver in performing the driving task, the distraction that such functions can cause must not be underestimated. Activation at the right time is therefore essential. If activation occurs too early, the driver expects a situation corresponding to the warning in a timely manner. If this does not occur, this can result in a loss of confidence in the warning. If the function is activated too late, it is correspondingly useless.

The intensity of the function or warning is similar. If the information

FIGURE 4 The display of lane markings could make it easier to keep in lane (© Ford)

is presented too weakly, it may be perceived poorly or not at all. If the information is presented too intensively and is therefore dominant, it may lose its supporting effect. It can then become the primary visual target and thus reduce the perception of the driving task again.

The last point to mention is how the information is activated over time. The correct activation speed ensures an appearance of the information that is just the right amount to attract attention, but not yet startling. Basically, the same applies to the information's disappearance: The disappearance of the information should be as unobtrusive as possible.

With what kind of edge you raise or lower the brightness plays a subordinate role. For warnings, it would be advisable to use a control curve that flashes something towards the end of its target brightness. For information, on the other hand, a linear display for the eye is preferable. The correct tuning of these parameters is therefore crucial for meaningful use and thus helpful for the driver.

GAMIFICATION – DISTRACTION IN A POSITIVE SENSE

A completely different aspect of a pixel headlight is the display of moving images. While driving, this would be accompanied by a major distraction. When stationary, however, this can be a distraction, albeit an amusing one, but also a very helpful one.

The subject of the well-being of vehicle occupants is now an integral part of modern vehicles. Relaxing ambient lighting for the interior, a meditation app, power nap support or the calming influence of seat vibrations are just a few of the extras that can be used to make the most of inactive time, for example during a charging process. So far, this has referred to the interior of the vehicle. But the headlights could now also contribute something here with pixel technology. The idea came about during a test drive by a development engineer. He got caught in a traffic jam and came up with the idea that the rear wall of a truck could be used as a projection surface for the pixel headlights. The idea of using it for entertainment purposes was born. Because a traffic jam is exhausting and even more so at night. A simple computer game could keep the driver active and awake and thus and thus ensure attention.

FIGURE 5 Especially in the dark, the indication of a winding road means additional safety (© Ford)

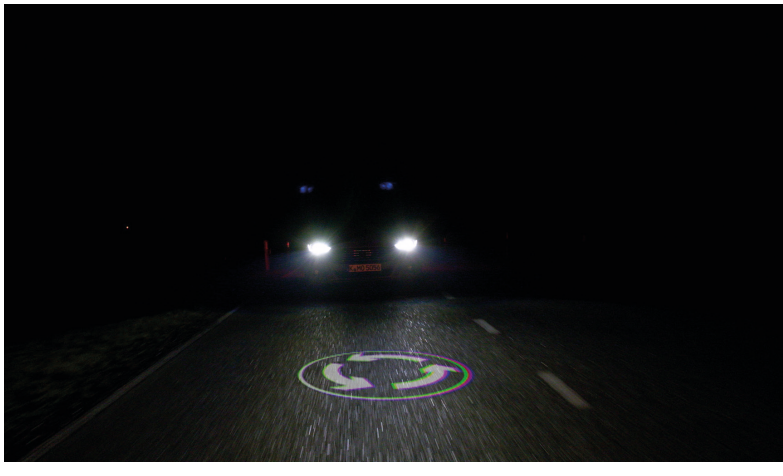

FIGURE 6 A roundabout can be announced in good time (© Ford)