AmbiCar: Towards an in-vehicle ambient light display

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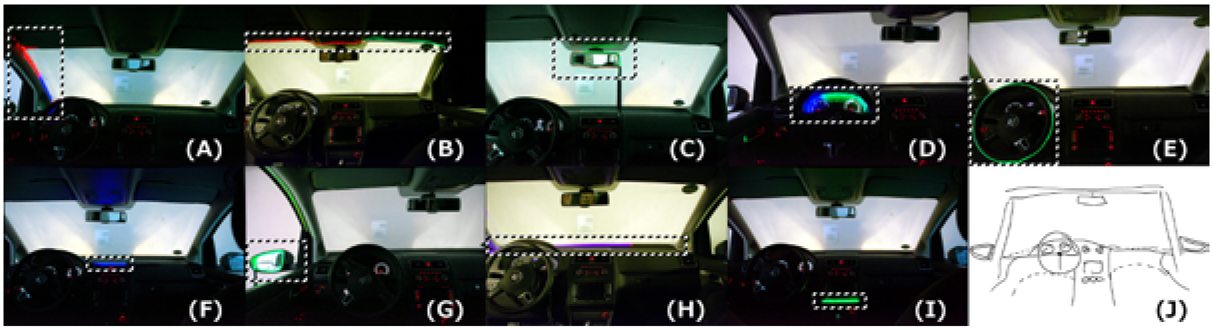

Figure 1: (A-I): Different locations for the ambient light display. (J): Basis for participants' sketches.

ABSTRACT

Several systems using different modalities have been introduced to assist drivers. We want to find out if peripheral vision is a less demanded cognitive resource while driving and therefore propose ambient light as an alternative modality for information presentation. In this paper, we propose different locations for an in-vehicle ambient light display and present first results of a survey regarding these locations.

Categories and Subject Descriptors

H.5.m [**INFORMATION INTERFACES AND PRESENTATION (e.g., HCI)**]: MISCELLANEOUS

General Terms

Design; Human Factors; Experimentation.

Keywords

Ambient light display; peripheral interaction; in-vehicle.

1. INTRODUCTION

Many systems using different modalities for the driver-car interface have been developed to assist drivers (e.g. [1, 2, 3, 4, 5]). However, assistant systems that warn against critical situations without taking the driver's state into account (e.g. health parameters or cognitive load) may surprise drivers who are not aware of a critical situation. Considering this, we want to enhance the driver's awareness by continuously displaying the criticality of the current driving situation. Further, we do not want to increase the driver's mental workload and therefore use a modality that addresses a lowly demanded mental resource, following Wickens' theory on multiple resources [7]. Peripheral vision may be such a resource and was successfully addressed in other domains using ambient light (e.g. [6]). On the contrary, foveal vision is a separate resource and already highly demanded, for example to recognize hazards or signs. We want to find out if peripheral vision is suitable and propose ambient light as a modality for information presentation during driving.

2. ONLINE SURVEY

In a first step towards an ambient light display, we needed to find out where to place it. We conducted a brainwriting session with five drivers and extracted nine locations. Based on that, we implemented prototypes at these locations.

Light patterns were designed by defining dynamic changes of colour, brightness etc. of the LEDs. Snapshots of the display are shown in Figure 1. Based on videos and pictures of the prototypes, we created an online survey to answer the following questions: Where do participants think it was easy to perceive a light display ($Q1$)? Where would participants prefer to have a light display placed ($Q2$)?

We took this approach to receive feedback from more participants compared to conducting a lab study. While doing so, one has to keep in mind, that the dynamics of ambient light can not be mapped to images. Hence, participant's answers may differ from results coming from a real in-car setting. However, we will be able to focus on few locations while evaluating different light behaviours in future work.

2.1 Procedure

After an introduction to the objective of the survey, we asked for personal information, such as age or vehicle model.

Next, participants could watch videos of different light patterns at different locations to get an impression of what is possible. They were reminded that the survey is about locations of a light display and not about these light patterns.

For each location shown in Figure 1, an image consisting of seven examples of light patterns was presented. Participants could rate each location for its perceptibility ($Q1$) and the participant's preference ($Q2$) using a seven-point Likert-type scale and comment on it.

Afterwards, participants were asked to select their favourite or the option *none of the shown*. In addition, they could sketch their own ideas for a location and comment on it. Finally, they could give general feedback regarding the survey.

2.2 Results

58 people participated in the survey (38 male, 19 female, 1 without answer). Most participants (24) were between 24 and 30 years old. Most drivers (19) received their licence 5 to 10 years ago. 8 participants stated they do not drive, 12 drive less than 5,000km per year, 15 up to 10,000km, 11 up to 20,000km and 12 more than that.

We used Friedman's ANOVA to test our findings regarding $Q1$ and $Q2$ for significant effects. In addition, we performed Wilcoxon signed-rank tests to follow-up our findings and applied Holm corrections. Effect sizes were calculated using the formula $r = \frac{Z}{\sqrt{N}}$, where N is the total number of the samples, and among other results shown in table 1.

Likings and perceptibilities differed significantly ($\chi^2_l(8) = 88.9, p < .001$ resp. $\chi^2_p(8) = 128.6, p < .001$). *(D)* is the favourite location for 18 people. Next, *(H)* was preferred by 10 participants. Both locations' perceptibilities were rated higher than for most other locations, but don't differ significantly. *(G)* and *(I)* were the least preferred locations. The perceptibilities of both locations were rated significantly lower than any other location. Looking into the ratings for likings, the results of *(D)* are significantly higher than the ones of most other locations, reflecting the high number of votes. Interestingly though, *(F)* and *(H)* are on the same level, both having higher ratings than *(E)*, *(G)* and *(I)*, which retrieved comparably low ratings.

We used Kruskal–Wallis ANOVA to search for differences between groups of participants regarding $Q1$ and $Q2$, performed Mann–Whitney's U tests to follow up our findings and applied Holm corrections. We found several gender-, age- and experience-related differences. For example, female participants liked *(E)* more compared to male participants ($\tilde{x}_{lAM} = 2$, $\tilde{x}_{lAF} = 4$, $r = -.32$), while men liked *(A)* more ($\tilde{x}_{lEM} = 4$, $\tilde{x}_{lEW} = 2$, $r = .31$). Though the analysis is not yet finished, also within most of the groups *(D)* seems to be preferred, while *(I)* seems to be the least preferred location.

Looking into the participant's sketches, a heads-up display (HUD) integrated into the windscreen is the most proposed alternative so far beside variations of the presented locations. Further analysis of the survey is yet to be done.

	#	$\tilde{x}_p$	$\tilde{x}_l$	r_{pD}	r_{pG}	r_{pH}	r_{pI}	r_{lD}	r_{lF}	r_{lH}
A	5	5	4	*	.47	*	.44	-.34	*	*
B	2	5	4	-.36	.38	-.37	.44	-.46	*	-.3
C	4	4	3	-.36	.39	-.32	.39	-.39	*	*
D	18	5	5	–	.53	*	.52	–	*	.28
E	4	4	3	-.42	.35	-.36	.38	-.45	-.34	-.29
F	6	5	5	*	.4	*	.53	*	–	*
G	2	2	2	-.53	–	-.49	*	-.46	-.33	-.29
H	10	6	5	*	.49	–	.51	-.28	*	–
I	1	3	2	-.52	*	-.51	–	-.48	-.52	-.36

Table 1: Number of votes for favourite location (#), medians for perceptibilities and likings ($\tilde{x}_p$, $\tilde{x}_l$) and effect sizes (r_{pX}, r_{lX}) for significant differences to other locations ($p < .05$ after correction). Non-significant effects were marked with * or dropped. The names of the rows refer to the names of the locations given in Figure 1.

3. CONCLUSIONS AND FURTHER WORK

As a first step towards an in-vehicle ambient light display, we conducted a brainwriting session and an online survey to find a suitable location for the display. According to our findings so far, the best location is *At the dashboard (D)*.

After analysing our results, we will be able to limit the number of prototypes that are needed to evaluate the locations in a more realistic setting. Furthermore, with a large number of participants, we may be able to identify different groups of drivers that prefer different locations.

A short-term goal is to evaluate different prototypes using different light patterns to display information to the driver. In the future, we plan to use ambient light as an additional modality for a multimodal driver interface.

4. ACKNOWLEDGMENTS

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