Requirements and evaluation of displays in autonomous cars

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Abstract
Autonomous driving has a huge impact of on displays: number, larger and more time to watch. This requires new approaches for optical evaluations.

1. Introduction

Future cars expand autonomous driving capabilities thus enabling an extensive use of in-vehicle displays. Cars will evolve toward the third living space. This raises the expectations from functional to emotional displays [1] and HMIs on more and larger displays. Additional displays for leisure and work will be integrated. Fig. 1 shows selected examples:

- Design for extensive manual driving (top left)
- Pillar-to-pillar singe large display and retraceable steering wheel with displays (top right)
- Displays for work and fun (bottom left)
- Curved displays is doors for leisure (bottom right)

Those displays are watched for longer time (hours) as today (seconds) which raise the bar on image quality, readability in bright light (no hoods etc.) and lifetime. Displays in autonomous cars dominate the interior design and therefore a high quality, seamless integration in mandatory for premium products.

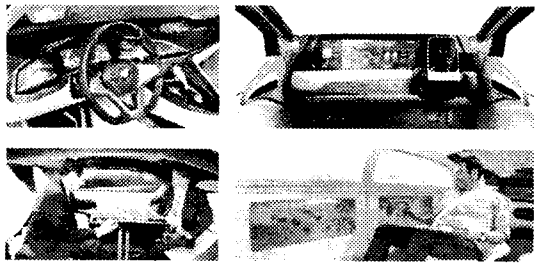

Figure 1: Interior design with various displays for autonomous cars: driving, leisure & work. Sources: BMW, NISSAN, PANASONIC, MERCEDES

2. Fundamentals of Optical Evaluation

Automotive displays are challenging in evaluation as the intended lifetime is about 15 years. Fig. 2 provides an overview of the fundamental challenges.

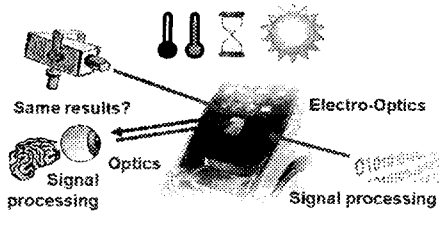

Figure 2: Visualization of optical evaluation for automotive displays like environment and display performance and image enhancement & perception (signal processing). Source: VOLVO (display)

3. Selected Examples for Automotive

Beside traditional methods for evaluating the optical performance of automotive displays, additional tasks for displays in autonomous cars are required, an overview is provided in [2]. The following list provides selected examples for basic measurements:

- Luminance: Define measurement for OLEDs (full screen or white box with black background).
- Contrast ratio: Lowest luminance for black to avoid postcard effect for LCDs during night drive. Verify dimming algorithms and effects on image quality for matrix backlights.
- Grey scale reproduction: Image enhancement algorithms for optimized perception in bright ambient light conditions.
- Color: All displays should be calibrated to same color despite potential metamerism.

Beyond that, displays in autonomous cars have to fulfil automotive application requirements such as:

- Lifetime: Define limits for OLED burn-in for given temperature profile and content (opera-tional data and entertainment). All large displays are expensive and difficult to replace in case of failure and have therefore to be tested extensively.
- Ambient light: Fig. 1 shows that most displays are stronger exposed to ambient light as today. High effective and durable (touch) reflection reduction coatings are required and tested.
- Power consumption and heat: All possible power saving methods have to be applied which can have influence on image quality.
- Viewing angle: Large interior LCDs are observed form a larger viewing cone than today (compare Fig. 1 top left to bottom right).
- Response time is typically long for low temperature operation. The effect on e.g. video perception has to be evaluated.

This effort is required for high quality reproduction of advanced HMIs and entertainment.

4. Summary

Future autonomous cars will be equipped with many and large displays. This sets new challenges for optical evaluation as significantly longer time is spent on watching displays like video and infotainment.

5. References

[1] Knoll, P. "The use of displays in automotive applications," J. Soc Info Display, p. 165-172 (1997)
[2] Blankenbach, K. "Advanced automotive display measurements: Selected challenges and solutions," J. Soc Info Display, p. 517-525 (2018)