

Context

Head Up Displays (HUD) for automotive applications are increasingly common with significant market growth. The communication between equipment, such as cameras and sensors, offers new possibilities for interactivity and Augmented Reality (AR) experiences. However, the mechanical packaging required takes up substantial volumes in the inner dashboard: an area where space is at a premium. The packaging volume of a HUD results primarily from the imaging optics used to create the virtual image a driver sees (typically several meters or more from the driver's position). These optics typically consist of at least one and possibly two free-form shape first surface mirrors and a flat first surface fold mirror. These items are bulky and space consuming. The size taken by a conventional catadioptric system, is linked to physical constraints and aberrations control and as such, new paradigms for HUD imaging systems are required to overcome those limitations.

Objective

The main PhD objective is to investigate and benchmark various alternative HUD approaches :

- holographic and waveguide solutions to replace catadioptric systems,
- use of Spatial Light Modulators as replacements or in addition to catadioptric systems,
- potential use of multi-stereoscopic vision (3D HUD without goggles).

The target will be to reduce the total system volume while maintaining or improving performance (view angles, visibility ...). The other major objective will be to introduce 3D (multi-plane) capabilities into the HUD to provide additional depth information: projecting information to appear at different distances from the user/vehicle.

Research program details

The student will initially perform a paper/bibliographic study and comparison of each of the above approaches: holographic/waveguide, SLM, multi-stereoscopic. Particular allowance will be made for the specific constraints of the automotive industry: compactness, cost, environmental, user acceptability etc.

The second stage in the PhD will centre on the design, simulation and prototyping of the most promising approaches using innovative refractive and diffraction optics to open the diffraction angle and to increase architecture compactness. The student will perform opto-mechanical characterisation of the prototype performance (measurements, qualification) and analyse system tolerances.

The final stage will be to investigate potential for 3D HUD capabilities. One possibility to be evaluated is the use of phase-only SLMs on which Fourier/Fresnel holograms are displayed in real time and then illuminated by a coherent (coloured) source to create moving patterns/symbols at various depths in the far field (on the road in front of the vehicle). A second route consists in using autostereoscopic optics to enable a relief perception for a car driver without the need for wearing eyeglasses. In this case, the illumination would be a conventional white source and the images to be created would be real images. The novelty is to insert in the optical system a refractive/diffractive panel enabling the creation of different views of an object in relief.

This PhD subject clearly requires a good understanding of HUD technology and diffractive optics. Familiarity with the optical stack concept is also mandatory to anticipate market expectation, improvement of the technology and adaptation (if needed) to the production process.

Candidate profile

An engineering or masters degree in optics/photonics with experience of optical system design and simulation (raytracing: CodeV, Zemax LightTrans ...). Knowledge of diffractive optics and/or automotive applications would be an advantage. Capacity to work in English is mandatory.

Location: IMT-Atlantique, Brest campus, Optics department.



Industrial (CIFRE) PhD Position

Design, prototyping and characterisation of compact, high view angle, 3D Head Up Displays (HUD) for automotive applications.



Supervision: Prof. JL de Bougrenet de la Tocnaye, Prof. K. Heggarty

Type of grant: ANRT – Cifre.

Contacts:

- K. Heggarty (IMT Atlantique) : kevin.heggarty@imt-atlantique.fr
- P. Mermillod (Valeo) : pierre.mermillod@valeo.com