DOID Student Optical Design Challenge for VR/AR and MR

Call for Entries details

Eligibility
- The optical design challenge is open to any student registered at an academic or research institute, performing their work either in an academic lab or research institute or as an internship in an external company.
- Participants must be able to attend SPIE Photonics Europe 2018 in Strasbourg to present a poster and make an oral pitch. Students who require travel support should indicate this when submitting the design.
- Participants are required to register for the conference (note student pricing available).

Application and competition process
1. Choose one or (maximum) two of the design challenges, see the specifications below.
2. Write an abstract for your design solution.
3. Submit your abstract to the competition webpage www.spie.org/challengesubmit. The abstract, due by 1 December, needs to show the “idea” for the challenge being addressed. The design should be described in the standard way designs are described in SPIE papers—results from design software, but not the actual file. Submitting your abstract is your entry to the design competition.
4. The final paper describing the design in detail is due 6 April.
5. Designs accepted to the competition will need to present a poster describing the design solution.
   Paper authors need to presenter their design in a 3-5 minute oral pitch to the jury.

Timeline
1 December  Application deadline
31 January  Participant notification
2 April  Registration prices increase
6 April  Submit final paper
22-26 April  Poster presentation
22-26 April  Oral pitch (3-5 min for Jury)
22-26 April  Awards presentation
Judging
After the abstract deadline, application materials will be reviewed by a Jury made up of industry leaders in the AR, MR, and VR fields. The Jury will grade the optical design and the resulting optical specifications (including tolerancing). The Jury will also grade the presentation of the work, along the following criteria:

- Novelty of the optical architecture / optical technology used
- Quality of the state of the art analysis
- Closeness of the resulting design to the target specs
- Quality of the written paper along SPIE manuscript redaction rules
- Quality of the poster presentation
- Quality of the oral pitch presentation in front of the jury (3-5 minutes pitch).

One student within each of the following categories whose design comes the closest to reaching the design goals will be recognized at SPIE Photonics Europe.

- Designing a limited FOV monocular see through smart glass imaging system.
- Designing a compact optical combiner for see through binocular AR (waveguide or free space).
- Designing a compact foveated optical imaging system for large FOV binocular VR.
- Designing a compact Vergence-Accomodation Conflict (VAC) mitigation display system for AR or VR.
**DESIGN CHALLENGE #1:**

**First option:** Designing a limited FOV monocular see-through smart glass imaging system.

This challenge consists of designing an optical architecture for a smart glass display, along the following specifications:
- Diagonal FOV >= 20 deg. (aspect ratio can vary).
- Eyebox: as large as possible
- Angular pixel resolution: as small as possible (<= 1.5 arc min).
- The optical device should look close to a standard pair of glasses.

The resulting design can be either totally novel, or can be an optimization of an existing architectures. Not all specifications need to be reached to win. The jury will assess the novelty of the architecture as well as the quality of the design. These loose specs allow the student to come up with non standard architectures.

**Examples of existing architectures include:**
- Google Glass V1 and V2 (LCOS and LCD and bird bath architecture)
- Toshiba Glass (LCOS and embedded Fresnel reflector combiner)
- Zeiss Smart Glasses (MicroOLED display and curved waveguide with Fresnel extractor)
- Optinvent ORA (LCOS and 1D exit pupil expansion through waveguide and prism array)
- Vuzix M3000 (MicroOLED and 1D exit pupil expansion through waveguide grating)

**Second option:** “Designing a compact see through Augmented Reality (AR) binocular display system”.

This challenge consists of designing a novel optical architecture for a see through Augmented Reality (AR) Head Mounted Display (HMD), along the following specifications:
- Diagonal FOV >=40 deg. (aspect ratio can vary).
- Eyebox size: as large as possible
- Angular pixel resolution: as high as possible (<=1.5 arc min).
- The device should be the smallest and the lightest possible.
The resulting design can be either totally novel, or can be an optimization of an existing architectures. Not all specifications need to be reached to win. The jury will assess the novelty of the architecture as well as the quality of the design.

**Examples of existing architectures include:**

- ODG R9 (Micro-OLED and reflective bird bath free space type combiner).

- Lumus DK50 (LCOS and 1D exit pupil expansion through cascaded partial mirror waveguide)

- Meta 2 (LCD panel and reflective combiner)

- Microsoft Hololens (LCOS and 2D exit pupil expansion through surface relief waveguide combiner)

This figure below lists some of the optical architectures used today for smart glasses and AR headsets.
DESIGN CHALLENGE #2:

"Designing a compact Virtual Reality (VR) binocular display system with fixed optical foveation".

This challenge consists of designing an optical architecture for a Virtual Reality (VR) Head Mounted Display (HMD), with the following target specifications:
- Diagonal FOV >= 100 deg. (aspect ratio can vary).
- Angular pixel resolution: high in the fovea region (center), can be lower in the periphery of the FOV.
- Eyebox size: as large as possible
- The device should be the thinnest and the lightest possible.

The resulting design can be either totally novel, or can be an optimization of an existing architectures. Not all specifications need to be reached to win. The jury will assess the novelty of the architecture as well as the quality of the design.

Examples of existing architectures include:

- Oculus CV1, HTC Vive and Sony PS VR (hybrid Fresnel or refractive lenses)

- Dlodlo Glass V1 and e-magin VR glasses (pancake polarization lenses)

- The figure below shows some of the optical architectures used in VR - standard refractive, hybrid refractive/Fresnel or refractive/diffractive, (left), Pancake polarization display architecture (right)
DESIGN CHALLENGE #3:

"Designing a compact Vergence-Accommodation conflict (VAC) mitigation display architecture for AR, VR HMDs, HUD or desktop display".

This challenge consists of designing a novel optical architecture to mitigate the Vergence-Accommodation Conflict (VAC) present in standard fixed focused stereo displays, which are the basis of most of the AR and VR HMDs available in industry today.

- Target FOV: as large as possible
- Target image location change: infinity to close up
- Target angular resolution as good as possible
- The device should be the thinnest and the lightest possible.

The resulting design can be either totally novel, or can be an optimization of an existing architectures. Not all specifications need to be reached to win. The jury will assess the novelty of the architecture as well as the quality of the design.

Examples of existing VAC mitigation architectures include:

- Varifocal (slow focus tuning lenses)
- Multifocal (fast switching focus lenses – aka temporal light field)
- Spatial light fields using micro-lens arrays (see NVidia microlens array light field)
- Tensor displays (see Stanford University tensor display)
- Dynamic holographic for per pixel depth display (see Microsoft Research holographic display glasses)

The figure below depicts the conflict between Vergence and Accommodation in immersive displays.

Spatially multiplexed Light Field display (nVidia Corp).
Temporal light field display (Avgant Inc)

Pin light display: defocused point sources (MIT Media Lab, Stanford U)

Tensor display (Stanford University)

Holographic near to eye display, Microsoft Research
DESIGN CHALLENGE #4:

"Open" AR/VR/MR design challenge:

This challenge is an open design challenge.

The students have the choice of working on any optical system, sub-system or even technological building block to enhance AR, VR or MR experience in a HMD device such as in:

- Optical light engine (illumination)
- Display sub-system (2D panel or micro-display, 2D or 1D MEMS scanner, fiber scanner, phase panel, etc...)
- Optical engine including novel imaging optics and/or combiner optics
- Eye box expansion techniques
- Foveation techniques, etc...
- Head worn sensors (inside-out sensors) such as
  o head tracking, gesture sensing,
  o gaze/eye tracking,
  o iris authentication,
  o depth map sensors (structured illumination, time of flight (TOF) or other...).

The resulting proposal can be either totally novel, or can be an optimization of an existing architectures. The jury will assess the novelty of the technology/design/architecture as well as the quality of the design.