3D-printed adapters for standardized radiometric, photometric and temporal display calibration measurements of the HTC Vive Pro Eye virtual reality headset

Technical note

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BACKGROUND & MOTIVATION

The rapid growth of virtual reality (VR) technologies has made them a commonly-used tool in neuroscientific research and driven the need for precise and standardized procedures to characterize the spectral and temporal properties of head-mounted displays (HMDs). Accurate measurements of their radiometric and photometric properties (such as spectral radiance, spectral irradiance, luminance and illuminance) and their temporal behavior are critical for many experiments where precise stimuli need to be delivered.

However, conducting repeatable measurements inside VR headsets remains a challenge due to their complex optical designs and the lack of standardized tools for aligning measurement devices. Most HMDs require custom rigs to maintain proper positioning of sensors, making it difficult to compare results across studies or replicate setups. This work addresses these challenges by introducing two 3D-printable accessories specifically designed for the HTC Vive Pro Eye, enabling consistent and repeatable placement of radiometric and temporal measurement instruments. To promote reproducibility, the designs are released under an open license, enabling other researchers to modify the 3D models to fit different HMDs, supporting a broader range of experimental setups and fostering standardization across platforms.

SCOPE

This contribution includes two custom-designed accessories tailored for the HTC Vive Pro Eye HMD:

1. **Radiometric adapter**: Designed to position a JETI spectraval 1501 spectroradiometer at the approximate eye position of a typical user, this mount ensures stable and repeatable alignment for accurate irradiance measurements of the screen.
2. **Temporal response adapter**: Designed to secure two Thorlabs DET36A2 detectors in place in front of the display corresponding to each eye, enabling independent profiling of their temporal properties using an oscilloscope (tested with the PicoScope 2000).

These accessories are intended for researchers conducting photometric, radiometric, or temporal evaluations of VR displays and are particularly useful for display calibration, perceptual experiments, or hardware benchmarking.

Figure 1. Photographs of the installed radiometric adapter (left) and temporal response adapter (right) with the corresponding measurement equipment.

DESCRIPTION

Both accessories were designed using CAD and printed with PLA. Additionally, some of the pieces were assembled using screws as illustrated.

1. Radiometric adapter.

This mount positions a JETI spectraval spectroradiometer at the headset's eye relief point with minimal angular deviation. The design ensures that every time the spectroradiometer is secured to the adapter, it rests in approximately the same position and angle with respect to the lens of the headset, and at the approximate eye position of a user. The mount fits snugly inside the headset and is secured into place using the existing screws at the side. It features a slide to which the spectroradiometer can be secured using a screw.

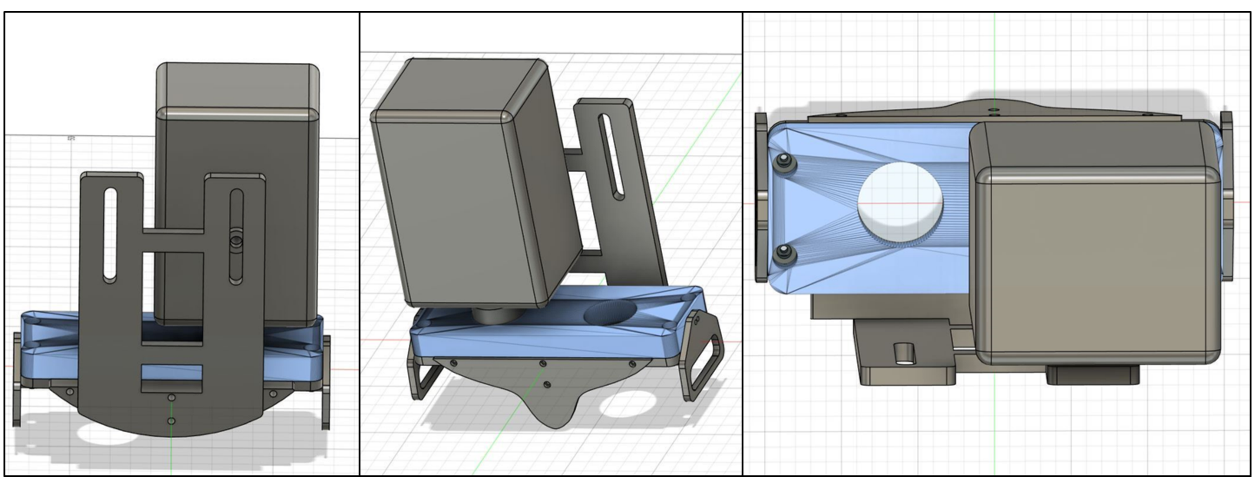


Figure 2. 3D renders of the radiometric adapter from a bottom (left), top (middle) and front (right) view.

2. Temporal response adapter

Designed to hold two Thorlabs detectors, this adapter fits snugly within the facial interface of the Vive Pro Eye. The diodes are directed at the central portion of each eye display. The wires from the photodiodes are routed out through the bottom and connected to an external oscilloscope for temporal analysis. Several screws secure the detectors into place firmly. An internal divider separates both lenses to reduce stray light interference between both displays.

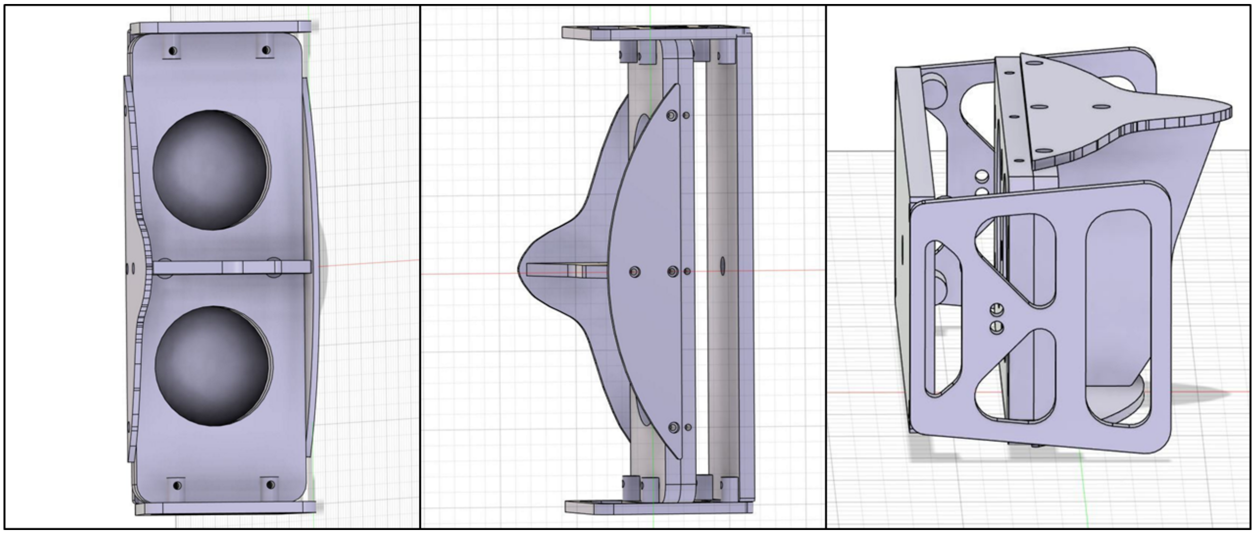


Figure 3. *3D renders of the temporal response adapter from a front (left), top (middle) and side (right) view.*

INSTALLATION

1. Radiometric adapter

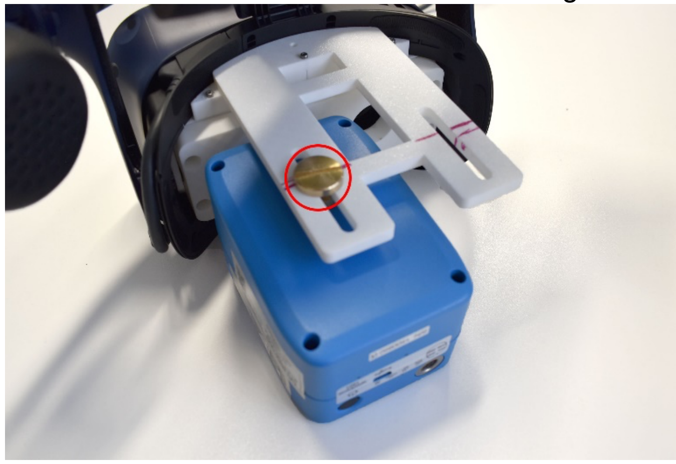
1. Remove the internal screw at the side of the headset using an appropriate screwdriver.

2. Fix the side part of the adapter into place using the internal screw.

3. Repeat these two steps for the other side part of the adapter.

4. Place the larger component of the adapter into place and fix using the four screws at the sides.

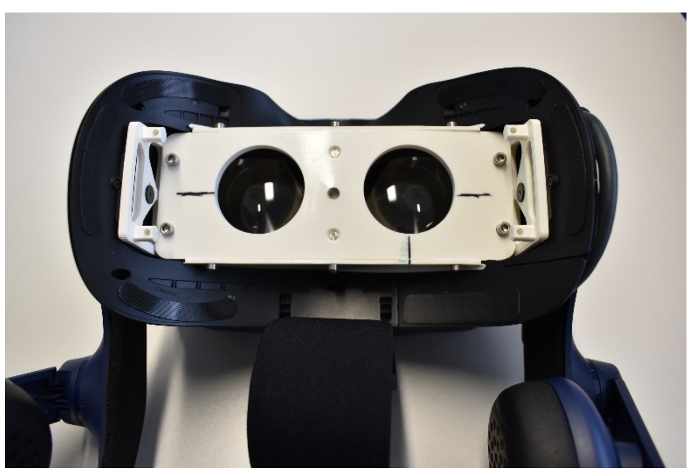
5. Place the spectroradiometer and secure into the slider using the screw as illustrated.



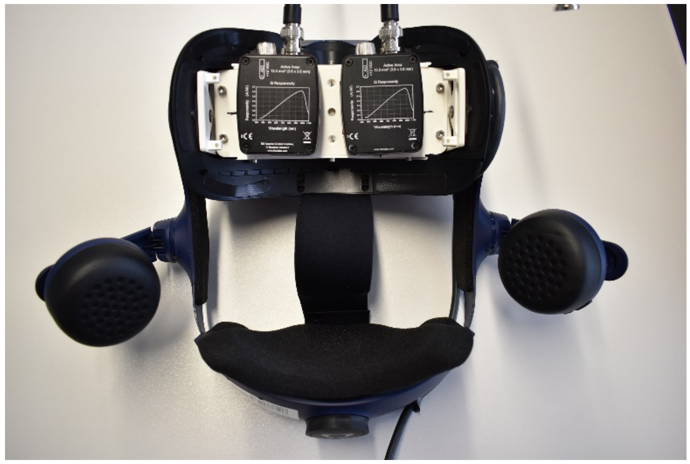
2. Temporal response adapter.

1. Remove the internal screw at the side of the headset using an appropriate screwdriver.

2. Place the bottom piece of the adapter and fix it in place using the internal screws of the headset at the sides.



3. 3. Place the detectors in the correct position.



4. Secure the detectors by placing the cover plate and securing it to the bottom piece of the adapter using the four screws at the corners and the bigger screw at the center.

LICENSE

FILE LIST

The following files are included with this technical note:

- **models/:** 3D models for the adapters
  - **radiometric_adapter.step**: 3D model for radiometric adapter
  - **temporal_response_adapter.step**: 3D model for temporal adapter
- **images/**: rendered images of the adapters
  - **render_radiometric_adapter_bottom.jpg**
  - **render_radiometric_adapter_front_with_spectroradiometer.jpg**
  - **render_radiometric_adapter_front.jpg**
  - **render_radiometric_adapter_side.jpg**
  - **render_radiometric_adapter_top.jpg**
  - **render_temporal_adapter_bottom.jpg**
  - **render_temporal_adapter_front_with_cover_plate.jpg**
  - **render_temporal_adapter_front_without_cover_plate.jpg**
  - **render_temporal_adapter_side.jpg**
  - **render_temporal_adapter_top.jpg**
- **LICENSE.txt**: Licensing terms

ACKNOWLEDGMENTS

This research was funded by the Max Planck Society in the form of a free-floating Max Planck Research Group (M.S.).