Introduction to Odak: a Differentiable Toolkit for Optical Sciences, Vision Sciences and Computer Graphics

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Abstract: This paper introduces Odak, an open-source toolkit that provides various differentiable simulation models for optical sciences, vision sciences, and computer graphics for gradient-based optimizations.

1. What is Odak?

Odak is the fundamental library for scientific computing in optical sciences, computer graphics, and visual perception [1]. It includes modules for simulating raytracing, wave optics, calculating perceptually guided visual quality metrics, and tools such as importing and exporting three-dimensional point clouds, CAD design files, and visualization during a design process. All of the modules presented in Odak are compatible with machine learning approaches with the PyTorch learning framework. Odak has documentation and many test scripts to help researchers work on their projects. Odak can run using CPUs or NVIDIA GPUs to increase the calculation speed by leveraging parallelization.

2. Example Usages of Odak

2.1. Computer-Generated Holography

Odak contains essential functions for computer-generated holography such as light transport models (refer to odak.learn.wave.classical L11-258) and optimization routines for hologram calculation (refer to odak.learn.wave.classical L261-488). One can use both hologram generation routines presented in the Odak or create his calculation methods using custom propagation models [2], or different targeting schemes and loss models [3].

2.2. Visual Perception

Odak also provides a perception module to model visual perception. This module host functions for foveation methods and particularly gaze-contingent perceptual loss functions. An example of perceptual loss functions in Odak is metameric loss [4, 5]. This loss function enforces the optimized image to be a ventral metamer to the ground truth image.

2.3. General Toolkit

Odak provides a set of functions that can be used for general-purpose work, such as saving an image file or loading a three-dimensional point cloud of an object, working with dictionaries. Odak toolset also provides various matrix transforms in a differentiable manner for gradient-based optimization routines.

References

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