Theory-Trained Neural Networks for advancements of waveguide-based applications towards augmented reality (AR), fiber endomicroscopy and quantum fiber communication

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Theory-trained neural networks can serve as a universal functional approximator, embedding the knowledge of physical systems such as waveguides for AR, multicore fibers for endomicroscopy and multimode-fiber-based communication into the learning process. This prior knowledge acts as a regularization factor during neural network training, which can increase generalizability and interpretability and shorten the training period towards paradigm shifts for AR, biomedicine and quantum technology within IYQ 2025.

Multiple Wiener filters for deconvolution are presented. For AR, image reconstruction can be performed at video rate, paving the way for real-world applications such as see-through camera and eye tracking as an extension of AR head-mounted displays. Fiber endomicroscopy exploits multiple Wiener filters towards single-shot, keyhole-access 3D imaging at video rate. We present also advancements for quantum communication using multimode fibers and theory-trained neural networks. The paradigm shifts are promising for biomedical imaging, computational imaging at AR and quantum information transmission.

Short Bio:

Juergen W Czarske (Fellow EOS, OPTICA, SPIE, IET, IOP) is director and full chair professor of the TU Dresden, Germany. His awards include the 2019 OPTICA Joseph-Fraunhofer-Award/Robert-M.-Burley-Prize in Optical Engineering and the 2024 SPIE Dennis Gabor Award in Diffractive Optics. Juergen fosters talented students early. The students and members of his lab have won over 100 prizes, including Bertha-Benz award of Daimler Benz Foundation. Juergen is Vice President of International Commission for Optics, ICO, and was the general chair of the world congress

ICO-25 with 3 Nobel laureates and attendees from 55 countries. Juergen also serves on the editorial boards of Light Science and Applications, Advanced Photonics and Light Advanced Manufacturing.