

Lensless 3D imaging using deep neural networks and quantum technology using entangled photons towards biomedicine

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Minimally invasive endoscopic imaging is essential for several important biomedical imaging applications such as neurosurgery. However, conventional fiber optic endoscopes require bulky lens systems and usually only enable 2D imaging. Both challenges can be overcome by tiny diffusers with the encoding of 3D objects into 2D speckle patterns. However, decoding places high demands on both speed and spatial resolution. Video rates and cellular resolution were achieved using a combination of U-Net and a physics-informed neural network, using spatially varying deconvolution through multiple Wiener filters. The diffuser fiber endoscope is promising for in vivo deep brain diagnostics with cellular resolution and keyhole access. Advances in physics-informed neural networks, quantum imaging with entangled photons, and multiplane light conversion for mode decomposition are outlined. Unconventional lensless 3D imaging with multicore fibers and diffusers as well as second-generation quantum technology hold promise for a paradigm shift in biomedicine.



Short Bio:

Juergen W Czarske received PhD degree in engineering and physics from Leibniz University, Germany. Prof Czarske (Fellow EOS, OPTICA, SPIE, IET, IOP, Senior Member IEEE) is director, full chair professor and senator of the TU Dresden, Germany. He is director of Center Biomedical Computational Laser Systems (BIOLAS), director of institute for systems and circuits, and advisor of SPIE-OPTICA-Student Chapter Dresden. Prof Czarske is an international prize-winning inventor of laser-based technologies. His awards include the 2008 Berthold Leibinger Innovation Prize of Trumpf, 2019 OPTICA Joseph-Fraunhofer-Award/Robert-M.-Burley-Prize (awarded in Washington D.C.), 2020 Laser Instrumentation Award of IEEE Photonics Society, 2020 and 2021 SPIE Community Champion for volunteer activities, and 2022 SPIE Chandra S Vikram Award (presented in San Diego). Prof Czarske has conducted more than 1000 talks and papers, including more than 250 papers in peer-reviewed journals, over 150 invited talks and over 30 patents. He fosters talented students early. The students and members of his lab have won over 110 prizes, awards and honors, including Bertha-Benz award of Daimler Benz Foundation (10,000 Euro). He is Vice President of International Commission for Optics, ICO, and was the general chair of the world congress ICO-25-OWLS-16-Dresden-Germany-2022 (two times postponed), which was co-sponsored by OPTICA, SPIE, IEEE, Zeiss, DGaO-The German Branch of EOS, IUPAP, TUD and City of Dresden. 3 Nobel laureates have delivered plenary lectures and the participants came from 5A (America, Asia, Australia, Africa and Amazing Europe).