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Optics and Photonics Group
Lunchtime Seminar

"Full-color imaging using large-aperture meta-optics"

Prof Arka Majumdar

University of Washington

13:30 Monday 10 July 2023
Coates Building - C24
All Welcome

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MS Teams link

The miniaturization of image sensors in recent decades has made today's cameras ubiquitous across many application domains, including medical imaging, smartphones, security, robotics, and autonomous transportation. However, only imagers that are an order of magnitude smaller could enable novel applications in nano-robotics, in vivo imaging, mixed reality, and health monitoring. While sensors with sub-micron pixels exist now, further miniaturization has been primarily prohibited by fundamental limitations of conventional optics. Traditional imaging systems consist of a cascade of refractive elements that correct for aberrations, and these bulky lenses impose a lower limit on camera footprint. In recent years, sub-wavelength diffractive optics, also known as meta-optics have been touted as a promising replacement for the bulky refractive optics. However, the images taken with meta-optics, to date, remain significantly inferior to the ones taken with refractive. Especially, full-color imaging with a large aperture meta-lens remains an important unsolved problem. We employ computationally designed meta-optics to solve this problem and enable ultra-compact cameras. Our solution is to design the meta-optics such that the modulation transfer function (MTF) of all the wavelength across the desired optical bandwidth are the same at the sensor plane. Additionally, the volume under the MTF curve is maximized to ensure enough information is captured enabling computational reconstruction of the image. The same intuition can be employed for different angles to mitigate geometric aberrations as well. In this talk, I will describe our efforts on achieving full-color imaging using a single meta-optic and a computational backend. Starting from traditional extended depth of focus lens [1,2], I will describe inverse-designed meta-optics [3], end-to-end designed meta-optics [4] and hybrid refractive/ meta-optics [5] for visible full-color imaging. I will also talk about how these techniques can be extended for thermal imaging [6,7].

[1] S. Colburn et al., Sci Adv 4, eaar2114 (2018).
[2] L. Huang et al., Photon. Res. 8, 1613 (2020).
[3] E. Bayati et al., Nanophotonics 11, 2531 (2022).
[4] E. Tseng et al., Nature Communications 12, 6493 (2021).
[5] S. Pinilla et al., Science Advances 9, eadg7297.
[6] L. Huang et al., Opt. Mater. Express 11, 2907 (2021).
[7] V. Saragadam et al., arXiv:2212.06345 (2023).

Bio: Prof. Arka Majumdar is an Associate Professor in the departments of Electrical and Computer Engineering and Physics at the University of Washington (UW). He received B. Tech. from IIT-Kharagpur (2007), where he was honored with the President's Gold Medal. He completed his MS (2009) and Ph.D. (2012) in Electrical Engineering at Stanford University. He spent one year at the University of California, Berkeley (2012-13), and then in Intel Labs (2013-14) as postdoc before joining UW. His research interests include developing a hybrid nanophotonic platform using emerging material systems for optical information science, imaging, and microscopy. Prof. Majumdar is the recipient of multiple Young Investigator Awards from the AFOSR (2015), NSF (2019), ONR (2020) and DARPA (2021), Intel early career faculty award (2015), Amazon Catalyst Award (2016), Alfred P. Sloan fellowship (2018), UW college of engineering outstanding junior faculty award (2020), iCANX Young Scientist Award (2021), IIT-Kharagpur Young Alumni Achiever Award (2022) and DARPA Director's Award (2023). He is co-founder and technical advisor of Tunoptix, a startup commercializing software defined meta-optics.