3D and Hyperspectral Imaging Based on Light Correlations

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Plenoptic or lightfiled imaging is a recently developed imaging modality enabling both to modify the focused plane of acquired images, in post-processing, and to perform scanning-free 3D imaging.

The key is to retrieve both spatial and directional information about light from the scene of interest.

In conventional approaches, the effective potential of these devices is highly limited by the intrinsic strong trade-off between plenoptic capabilities and resolution. Still, the fast 3D imaging capability of lightfield cameras is attracting increasing attention. We have proposed and developed a novel approach to plenoptic imaging, named correlation plenoptic imaging (CPI), which enables addressing the intrinsic resolution versus depth of field (DOF) trade-off by exploiting the peculiar spatio-temporal correlations of both chaotic light and entangled photons.

In this talk, I will present recent experimental achievements in CPI: from the first proof-of-principle demonstration of its diffraction-limited plenoptic imaging capability, to the implementation in the realm of microscopy, where diffraction-limited resolution has been combined with a $6x$ DOF improvement, and the speed-up unabled by both SPAD arrays and AI. In fact, high-resolution volumetric imaging has been performed at 10 fps, and a further $20x$ seed-up has been achieved by means of deep learning. An extension of the approach for scanning-free high resolution hyperspectral imaging will also be discussed.