Beam steering and dynamic focusing with photonic integrated circuits

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Beam steering is the key enabling technology used in widespread applications, including light detection and ranging (LiDAR), free-space optical communication (FSO), and laser-scanning microscopes [1]. Compared to conventional bulky mechanical devices, beam steerers realized by photonic integrated circuits (PICs) show promise to offer miniaturized sizes, higher speeds, robust operation, and reconfigurability. In this invited talk, I will introduce our recent work on beam steering and dynamic focusing with PICs.

In the first part of the talk, I will report on a resolution-enhanced silicon photonic beam steerer [2]. The resolution of beam steerers has been a bottleneck since the number of resolvable points is approximately equal to the number of waveguide channels, no matter whether the steerers are based on optical phased arrays (OPA) or focal plane arrays (FPA). We increase the number of resolvable points by combining coarse steering with a metalens focal plane array and fine-tuning with serpentine microheaters. We demonstrate experimentally a resolution-enhanced 2D beam steerer, achieving 39 resolvable points with 13 waveguide channels in the azimuthal direction. We achieve experimentally a field-of-view (FOV) of 51.4° and an average FWHM divergence angle of 1.4°.

In the second part, I will introduce our research of a chip-scale confocal laser-scanning microscope based on an actively-controlled OPA [3–4]. The InP-based OPA consists of 30 elements and serves as a reconfigurable scan lens. We demonstrate the key functions needed for a laser-scanning microscope, including dynamic light focusing, collection, and steering, as well as confocal measurements to detect reflection at selective depths. We perform depth sensing by dynamically scanning the focal length and reconstruct 3D topology images that resolve a height difference of 8 μm.

References

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