Neural Array Meta-Imaging

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Abstract: Compact, high-quality, video-rate, full-color cameras are increasingly demanded in scientific, industrial, and consumer applications. Metalenses combined with computational imaging offer a promising solution for developing such systems, yet their performance is fundamentally constrained by inherent trade-offs between aperture size, F-number, field of view (FOV), waveband width and imaging quality. Here, we experimentally demonstrate that a neural array imaging model can break these long-standing trade-offs, achieving a 25 Hz full-color imaging meta-camera with a 2.76 mm aperture, 1.45 F number, 50° FOV, and a spectral range of 400-700 nm. The meta-camera produces image quality, object detection, and depth estimation performance comparable to commercial compound lenses (e.g. Edmund 33-300), while reducing the total track length by a factor of 13. This paradigm shift is also applied to polarization imaging, demonstrating its scalability and versatility for broadband applications. Our approach resolves the trade-offs in aperture size, waveband range, FOV, and imaging performance, paving the way for compact metasurface-based cameras in practical applications.