Aperture Synthesis with Metasurface-Based Radial Waveguides

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1. Extended Abstract

The generation of Bessel beams has garnered significant interest over the years. Bessel beams have several unique features including non-diffractive propagation, and self-healing properties. These features, amongst others, suggest possible applications in the areas of medical imaging, non-destructive evaluation, and wireless power transfer. Recently, Bessel beam generation in the microwave regime using leaky waves was proposed [1]. The structure reported in [2] employed an over-moded radial waveguide covered with a constant (homogeneous) impedance sheet. The radial waveguide was thin, lightweight, low-cost, and simple to feed with a coaxial connector. At microwave and millimeter wave frequencies, this structure offers significant size and weight advantages over conventional bulky lens arrangements [3]. The analysis of such structures, presented in [1], considered only a single leaky mode in the radial waveguide. In [4], the authors presented a rigorous, modal analysis of these Bessel beam launchers, and solved exactly for the free-space spectrum above the launcher. In other work [5], a metasurface lens was employed to collimate the radiation from the Bessel beam launcher reported [1,2]. This metasurface was placed above the launchers to change the polarization and phase of the aperture field.

In this work, the rigorous modal analysis developed in [4] is reformulated and used for the synthesis of various aperture field profiles. Unlike earlier work [5], the synthesis procedure allows the amplitude profile of the aperture field to also be reshaped. In the synthesis procedure, the fields above the launcher are stipulated, and modal coefficients of the discrete modes supported by the radial waveguide are solved for. From these modal coefficients, the required spatially-varying (inhomogeneous) sheet impedance is found that achieves the desired aperture field above the launcher. In the synthesis technique, power orthogonality relations are used to simply the system equations. At the conference, the proposed technique will be verified through several design examples that achieve targeted aperture fields

2. References

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