Lens Antennas Using QCTO Technique

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Quasi Conformal Transformation Optics (QCTO) is employed here to produce 3D gradient-index lenses. These lenses are able to improve radiation properties of conventional antennas, such as gain, side lobe levels and cross polarization.

In recent years, there has been an increased interest in QCTO, due to the fact that it can produce lenses with isotropic and non-dispersive materials (N. Kundtz and D. R. Smith, Nat. Mater., vol. 9, pp. 129–132, 2010). As a consequence, designs which utilize this technique have low losses and present a broadband response (O. Quevedo-Teruel, W. X. Tang, R. C. Mitchell-Thomas, A. Dyke, H. Dyke, L. H. Zhang, S. Haq, and Y. Hao, Sci. Rep., vol. 3, no. 1903, pp. 1–5, 2013).

Here, this technique has been applied to improve the radiation properties of a number of antennas: an aperture, a patch and a leaky slot antenna. Using this technique, phase fronts of those antennas has been mapped to the phase fronts of a plane wave. The performance of the designed lens antennas have been investigated by commercial FDTD software. Specifically, the simulated results of the leaky slot lens have been compared with previous works which made use of a hyper-hemispherical lens to produce directive beam in an ultra wide frequency range (A. Neto, IEEE Trans. Antennas Propag., vol. 58, no. 7, pp. 2238–2247, 2010.). Our simulations demonstrate that by using this technique, side lobe levels, directivity and cross polarization level have been improved considerably while maintaining the same height of the lens in (A. Neto, IEEE Trans. Antennas Propag., vol. 58, no. 7, pp. 2238–2247, 2010). Additionally, our design requires a less denser permittivity profile in comparison, so the total losses of the lens can be reduced. Nevertheless, the prototyping of this lens requires a more advanced manufacturing technique which will potentially increase the cost in a practical implementation.