Single Reflector Antenna for One Dimensional Beam Scanning

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Paraboloidal reflector antennas have scan capability limited to a range of a few beamwidths. Toroidal reflectors with generating curves in the form of a parabola or an ellipse have been employed for scanning in one plane (Kelleher, IRE National Convention Record, 1953, G. M. Peeler and D. H. Archer IRE International Convention Record, 4, 1, 242-257, 1956). A high aperture efficiency offset reflector antenna has been proposed to scan 0.5^{o} beams in the $\pm 30^{o}$ scan range (W. P. Craig, C. M. Rappaport and J. S. Mason, IEEE Trans. Antennas Propagat., 41, 11, 1481-1490, 1993). The scanning reflectors discussed in the above-mentioned references are under-illuminated, i.e. each feed illuminates part of the reflector. Many synthetic aperture radar applications require single reflector with multiple feeds, thereby producing scanned beams in one plane.

In this paper we present results of an investigation on single reflector antennas with scan capability over 10 to 12 beamwidths on each side of the axial beam in the elevation plane. The beams in the azimuth direction are required to be as narrow as possible. An exercise on reflector shaping using physical optics (PO) optimization with paraboloid as starting shape did not produce any significant improvements. Perturbation of Peeler and Archer's generating curve of the elliptical torus to maximize the directivity of the axial beam produced interesting results. Compared with an offset paraboloid with an F/D ratio of 2/3 the directivity of the unscanned beam of the optimized elliptical torus was 1.4 dB lower whereas for a scanned beam 10 beamwidths away from axis the latter had a 2.5 dB improved gain. We will discuss results of further optimization of the generating curve of the torus as well as perturbing the circular shape in the scan plane.