A METHOD USING FOCAL PLANE ANALYSIS TO DETERMINE
THE PERFORMANCE OF REFLECTOR ANTENNAS
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Array feeds for reflectors have a number of important uses which
include 1) generating contour coverage patterns, 2) correction for reflector
distortions, and 3) improved wide angle scan. Typical methods for
optimizing the array feed for each of these applications are very efficient
when a fixed array geometry is utilized and only the feed excitation
coefficients are optimized since only one set of radiation integral evaluations
is needed. For most existing methods, an optimization which allowed the
element type, spacing, and size to vary would be extremely time consuming
since a radiation integral evaluation would now be required for each feed
element at each step of the optimization process.

A new method for computing the performance of reflector antennas
with array feeds is presented that obviates the need to recompute the
reflector radiation fields when the feed element type, size, or spacing is
varied. This allows the optimization techniques to efficiently include size
and spacing as parameters.

The mathematical formulation is based upon the use of the Lorentz
reciprocity theorem, which convolves the focal plane distribution of the
reflector system with the feed element aperture field distribution to obtain
the element response. The antenna gain can then be obtained from both
these responses and the array gain. Thus the time consuming reflector
system radiation integral evaluation is only done once for a given scan
direction or reflector surface distortion for all array feed geometries
considered. The study was restricted to the case where the antenna is
illuminated by an incident plane wave and thus the performance evaluation
was restricted to only one observation direction. Optimizing shaped
antenna patterns would require making the correct transformation between
the far-field pattern and the focal plane distribution.

Examples are given using this technique to design an array feed for
the correction of gravity-induced distortions of a large dual-shaped ground
antenna, both conventional and beam waveguide (BWG), as well as the
design of an array feed for improved wide-angle scan.