Analysis and Feed Design of a Sparse Aperture Parabolic Reflector

Joshua M. Wilson*[(1)], Stephen D. Hartzell[(1)], Thang M. Tran[(1)],
Jonathan T. Black[(1)], Ronald J. Marhefka[(2)], Andrew J. Terzuoli, Jr.[(1)]
(1) The Air Force Institute of Technology, Dayton, Ohio, USA,
(2) The Ohio State University, Columbus, Ohio, USA,
a.j.terzuoli@ieee.org

Large reflector antennas are useful in remote sensing and communications due to their high gain. However, a major tradeoff in designing and building large reflector antennas is their ability to deploy. Typically, these antennas are permanently set up in a single location, meaning they cannot be easily moved to another location.

This paper presents a particular sparse aperture concept as a solution to the limited ability to deploy problem of large reflector antennas. The aim is to determine the feasibility of a sparse aperture parabolic reflector, and compare its performance to a filled aperture parabolic reflector. The sparse reflector contains the same surface area as the filled aperture, but poses a new technical challenge in computational electromagnetics due to its unconventional cross-sectional shape.

Because the frequency of interest is L-band (λ = 14.99...29.97 cm), the antenna dimensions are on the order of 100 meters. This is an electrically large problem, posing a challenge in simulating the antenna performance in the Far Field. Therefore, the use of Integral Equation and Asymptotic solvers is the primary means of simulation. Plane wave analysis using an Integral Equation solver on a surface mesh is performed as a starting point for the design. The reciprocity theorem is the basis for this starting point. In further analyses, a feeding structure is designed for the sparse reflector based on plane wave analysis.

The design of a feeding structure for the sparse reflector is non-trivial, and requires several design iterations, each one based on the previous analysis.