Accurate and efficient shaping of spacecraft antennas

POS is used to design antennas with a prescribed radiation pattern, in particular highly contoured beams. An accurate and efficient PO algorithm is used to establish the goals for an optimization procedure. The PO and the minimax algorithm are tailored to contoured-beam applications, ensuring unsurpassed speed and accuracy.

Applications

- **Shaped reflector for contoured beams**
  The shaping of the surface(s) is part of an optimization process where the shape is modified until an optimum performance of the radiation characteristics is achieved.

- **Array-fed paraboloid**
  Feed array excitation coefficients are optimized to produce a given pattern shape.

- **Pencil-beam antennas**
  Dual reflectors with general elliptical aperture can be optimized for high aperture efficiency by shaping the subreflector to provide best main-reflector illumination. Single reflectors may be designed for enlarged circular beam coverage.

- **Cosecant-squared beam**
  Radar antennas providing uniform signal strength for incoming targets at constant height.

- **Optimum scanning antennas**
  Single offset reflectors to provide uniform peak gain for all feeds in a multi-satellite application, by averaging the scan degradations over all feed positions.

*Gain contours for a shaped reflector with optimum performance on China. The satellite is located at the geostationary orbit over Equator, at 100° East.*
The POS GUI – easy inspection of the geometry by means of a 3D-view. Specifications to geometry and computations are given through the tree structure, and the tabs to the left allow to choose between the design window shown, the command setup window, and the results display. All parameters can be edited while an optimization job is running.

The method

Starting from a given reflector/feed configuration, the performance of the antenna is sampled over the desired far-field and/or near-field regions. The gain, side-lobe and cross-polar levels can be compared to the prescribed value, and the surface shape and/or feed excitations are modified until convergence towards the goals.

All calculations are performed using the same EM modelling principles as the TICRA reflector analysis software GRASP.

The surfaces are given either by means of spline expansions or Zernike polynomials.

A tailored, home-grown minimax optimization algorithm utilizes the sparsity of the problem to ensure a fast and reliable process with minimum memory requirements. To enhance the speed, analytical derivatives are implemented to the greatest extent.

Restrictions on the curvature of the shaped surfaces can be imposed as side-constraints to guarantee a manufacturable reflector profile.

Auxiliary tools

POS includes a pre-processing tool for setting up coverages by clicking on a World map. Additionally, initial reflector/array geometries can be defined for the optimization with the pre-processing tool.