Efficient Analysis of Reflector Antennas using GRASP

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GRASP has for many years constituted the de facto standard in the space community for advanced reflector antenna modeling. The tool has furthermore found widespread use in the earth station segment and within the VSAT industry, as well as for radio telescopes and quasi-optical networks. Such penetration has been made possible by constantly augmenting GRASP with new user-defined features using the most accurate algorithms available. The applied methods are bespoken to reflector antennas, thereby ensuring efficiency in the computational models whilst maintaining a high level of generality. This presentation will highlight some of the most recently implemented modeling features in GRASP.

Physical Optics (PO) is the desired analysis technique for reflector antenna radiation patterns. However, spacecraft antennas as well as other reflector systems often have structural elements that impact the patterns and do not lend themselves very well to PO analysis due to, for example, limited electrical size. Therefore, a hybrid PO/Method of Moment (MoM) technique was implemented in GRASP, where the electrically small parts can be analyzed with MoM, while the electrically large parts of the antenna are modeled using a large-domain, meshless PO algorithm. The latter offers significantly better performance than standard PO based on discretized surfaces.

To tailor the analysis methods to the reflector environment, GRASP implements a higher-order MoM that uses large higher-order quadrilateral patches of length up to two wavelengths, and higher-order polynomial basis functions. This results in lower memory requirements for typical applications compared to standard low-order basis functions such as RWGs, and is the reason why the MoM in GRASP can be applied to relatively large scatterers.

The curved higher-order patches needed by MoM are provided by an advanced internal quadrilateral mesher. The mesher is based on the paving principle, and therefore generates the quads directly rather than transforming from a triangular mesh. Moreover, the mesher has the capability for generating meshes with a large ratio between the largest and the smallest patch size. Hence, small patches can be applied on parts of the scatterer with rapid variations, and large two-wavelength patches can be used on the remaining parts.

The unsurpassed accuracy of GRASP, which has been instrumental for its widespread application, has more recently paved the way for its utilization in quasi-optical networks, or beam wave-guides (BWG), operating in the THz regime. While physically small, the reflecting elements in a BWG may be several hundreds of wavelengths and thereby imposing a challenging problem to the PO algorithm in terms of computational speed. TICRA has implemented a new technique based on plane-wave expansion of the field radiated by the individual reflectors in the BWG. The expansion is performed in regions where the field is focused, thus limiting the required number of modes and allowing a much more efficient evaluation of the incident field on the following reflector in the BWG. The procedure speeds up the PO integration time by orders of magnitude and provides much better accuracy than standard optical methods.