Fast Evaluation of Radiation Patterns for Dual Reflector Antennas

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Conventionally, the radiation pattern of a dual reflector antenna is evaluated in three steps. First, the radiation pattern of the feed is computed or measured. Subsequently, the field is propagated from the feed through the sub-reflector to the main reflector. Finally, the radiation pattern of the main reflector is evaluated assuming that the fields on its surface have been pre-computed at the preceding stage. Regarding the first stage, we assume here that the radiation pattern of the feed is known. The last step is often effected by performing a Physical Optics (PO) integral over the surface currents, assuming that these currents are related to the tangential magnetic field on the surface of the reflector. The PO contribution is often augmented by the Physical Theory of Diffraction (PTD) line integral, in order to improve the far sidelobe accuracy. In all cases, for problems with large electrical dimensions, the computation time is dominated by the (surface) PO integration time. To that end, the radiation pattern evaluation of the main reflector can be effected by a multilevel Fast Physical Optics (FPO) algorithm recently proposed by the authors (A. Boag and C. Letrou, IEEE Trans. Antennas Propagat., 53(6), 2064-2072, 2005).

In this work, we focus on the intermediate step, viz., the computation of the field produced by the sub-reflector over the surface of the main one. This computation can be performed via ray-tracing; however, this approach is not accurate for small and medium size sub-reflectors. Therefore, we prefer the PO also for the sub-reflector analysis. Fast evaluation of PO integrals at arbitrary shaped observation domains located at finite distances can be performed by the Non-uniform Grid (NG) approach, where the source domain is split into sub-domains and the fields of the sub-domains are computed on the NGs and subsequently interpolated to the target surface (A. Boag, *Microwave Opt. Tech. Lett.*, 35(3), 240-244, 2002). Following a similar path, we split the sub-reflector into a number radiating sub-apertures. On the other hand, we propose to perform the field computation and interpolation directly over the main reflector, thus, avoiding the need for constructing the NGs. Smoothness of the main reflector surface is the key to providing those additional simplifications. The performance of the resulting algorithm will be demonstrated on typical offset dual reflector designs (C. Granet, IEEE Antennas Propagat. Mag., 44(3), 114-123, 2002).