A Fast Transient Analysis of Radiation from Reflector Antennas Using the Expansion of Feeding Fields via Complex Source Beams

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A complex source beam (CSB) is the geometrical field radiated from a electromagnetic (EM) source located in complex space, where the ray caustics exist in complex space, too. As a result, it avoids the problems of ray caustics in real space, and can be used to analyze many classical EM problems not applicable to be solved by the real ray based techniques such as conventional geometrical theory of diffraction (GTD). The transient analysis of radiations from the reflector antenna is one of examples of interest to the EM society.

This paper presents the development of a time-domain complex source beam (TD-CSB) technique based on an analytic time transform (ATT) of its frequency domain (FD) counterpart. The analytical formulations of TD-CSB are first obtained. The characteristics of TD-CSB are investigated afterward to examine the fundamental phenomena of a single TD-CSB in terms of incident TD-CSB in free space, its reflected fields and edge diffracted fields when the incident TD-CSB illuminates a curved wedge. This technique is further implemented for the fast analysis of radiation from a reflector antenna when it is illuminated by the radiation of a feed antenna. In this case, the representation of feed radiation in terms of TD-CSBs is developed such that the TD radiation from the reflector antenna can be found by the superposition of scattered TD-CSB. An efficient expansion algorithm is developed. This TD-CSB retains the advantages and characteristics of real space TD Uniform Geometrical Theory of Diffraction (TD-UTD) while, in the meantime, avoids the difficulty of ray caustics encountered in TD-UTD. Thus it not only predicts the transient responses with physically meaningful interpretations of wave propagation via the complex ray tracing, but also is as efficient as the TD-UTD. Numerical examples are presented to demonstrate its utilization and validity.