Investigation on correlations between Antenna Physical Structure and SEM-based Transfer Function for Various Types of Antennas

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In order to meet given antenna design specifications, antenna designers typically deal with various parameters, including size, radiation pattern, gain, polarization, return loss, and bandwidth. Experienced antenna engineers may start a design by considering a candidate structure with a circuit model satisfying the return loss and bandwidth performance as well as an equivalent current distribution providing a desired radiation performance. Typically, an antenna circuit model, including lumped and distribution elements, is valid in a limited bandwidth. We also need to be careful that an arbitrary current distribution over antenna structure may not be allowed due to limitations of some fundamental physics. Therefore, the antenna design process often involves optimization to satisfy all the required specifications. Comparing the equivalent circuit model and current distribution design process, an alternative approach based on an antenna transfer function may offer a time-efficient and intuitive design process.

In this presentation, antenna transfer functions based on a pole/residue representation with the singularity expansion method (SEM, Baum, 1971) are initially investigated for various types of antennas, including a dipole (resonant), a spiral (frequency-independent), and a tapered slot (ultra-wideband) antenna. The SEM-based antenna models provide a complete and compact description of the antenna characteristics in both frequency and time domains (Licul, 2004).

In order to understand a correlation between the physical antenna structure and the SEM-based model, pole location and residue amplitude changes will be tracked, along with the change of critical design parameters. For example, the design parameters for the dipole include an overall length, a radius of wire, and loss. In a similar way, the correlation for other types of antennas will also be discussed.

The investigated correlation information between the physical structure and transfer function provide a useful framework toward the antenna-element synthesis problem.