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Characteristic Mode Analysis as a Pattern Recognition Technique for Electromagnetic Compatibility

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Extended Abstract

The surface currents generated by external disturbances on the surface of technical systems are a key quantity for Electromagnetic Compatibility (EMC) analysis. Maxima of the surface currents indicate positions of high electromagnetic field strengths where disturbing fields may dominantly couple into the interior of a system [1]. The characterization or comparison of different surface current distributions often is done by visual inspection or by considering current values along a one-dimensional line, which is not very systematic.

In Characteristic Mode Analysis, an integral equation of the form $\mathscr{L}(J) = -E^s$ is considered which relates a known excitation E^s to an unknown surface current distribution J. This integral equation can be converted to an eigenvalue equation, yielding the characteristic modes J_n which form a complete basis such that the surface current J can be written in the form $J = \sum_n \alpha_n J_n$, compare [2, 3]. The characteristic modes J_n appear as resonance patterns, as exemplified in Fig. 1.

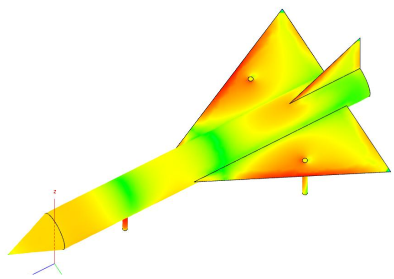

Figure 1. A typical characteristic mode pattern of an aircraft structure which constitutes a building block for a general surface current distribution. Red areas indicate a large, green areas a small surface current magnitude.

The patterns of the characteristic modes are influenced by the boundary conditions that are implied by the properties of the technical system under consideration. A modification of the boundary conditions can be used to suppress unwanted current maxima in a systematic way, which is useful for EMC protection. Additionally, the eigenvalues of characteristic mode analysis provide parameters, such as the so-called modal significance [3], that allow quantifying the difference between different surface currents in a systematic way. In the context of EMC test procedures this possibility is important if different EMC susceptibility test setups, as those discussed in [4], have to be compared, for example.

References

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