

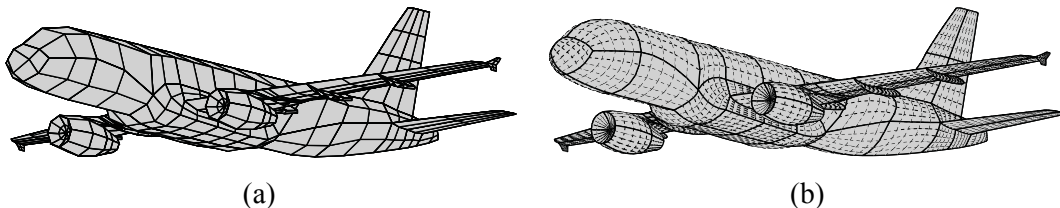
On the Higher-Order MoM-PO Electromagnetic Modeling of Vehicles

Miroslav Djordjević and Branislav M. Notaroš*

University of Massachusetts Dartmouth, ECE Department
285 Old Westport Road, Dartmouth, MA 02747, bnotaros@umassd.edu

Modern radio, wireless, and satellite communication and radar systems often involve vehicles (cars, airplanes, helicopters, spacecraft, etc.). From the electromagnetic point of view, the vehicles are three-dimensional radiating and scattering structures of complex shapes. They are so complicated and general that classical electromagnetic analytical techniques cannot be used. On the other hand, they are too expensive and impractical to be used as physical models in measurements. Consequently, numerical tools have to be developed and used. In addition, given that today's communication and radar applications cover practically the entire radio spectrum, vehicles included in the communication and radar systems range from electrically very small to ultra large objects. Analysis of vehicles as electromagnetic structures is, by all means, one of the most challenging and practically important problems of applied computational electromagnetics.

This paper presents our work and recent contributions to the electromagnetic modeling and analysis of airplanes and automobiles. The vehicles are analyzed using an efficient and accurate higher-order, large-domain hybrid computational technique based on the method of moments (MoM) and physical optics (PO). The technique utilizes large generalized curvilinear quadrilaterals of arbitrary geometrical orders in both the MoM and PO regions. It employs higher order divergence-conforming hierarchical polynomial basis functions in the context of the Galerkin method in the MoM region and higher order divergence-conforming interpolatory Chebyshev-type polynomial basis functions in conjunction with a point-matching method in the PO region. The new technique exhibits an excellent accuracy and flexibility at modeling of both current variation and curvature of complex objects (vehicles). As an example of higher order geometrical modeling, shown in the figure are the geometrical models of a commercial aircraft constructed from 728 bilinear (first-order) quadrilateral elements and 182 biquadratic (second-order) quadrilateral elements, respectively, where using the second-order geometrical approximation provides a dramatic improvement in the precision of the geometrical model and the overall accuracy of the MoM-PO scattering simulation. Several examples of the MoM-PO analysis of aircraft and automobiles to be presented demonstrate the efficiency and accuracy of the hybrid higher-order computational technique and its advantages over conventional techniques and low-order (small-domain) models.



Higher-order large-domain MoM-PO simulation models of a commercial aircraft using (a) 728 bilinear quadrilateral elements and (b) 182 biquadratic quadrilateral elements.