Printed Antennas Studies Based on Equivalent Magnetic Current Characteristic Modes

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In the past 10 years due to their attractive features, the characteristic modes have been applied widely for the wideband and Multiple Input Multiple Output (MIMO) antennas design. In these works the radiator was a metallic structure located in air. Fabres in [M. C. Fabres, "Systematic Design of antennas using the theory of characteristic modes." Universidad Politecnica de Valencia, Valencia, Ph.D. dissertation, pp 118-120, February 2007] applied the classical theory of characteristic modes to study parallel plates separated by air. However, utilizing the typical characteristic modes analysis the resulting electric eigencurrents do not give clear information about the structure radiation.

From electromagnetic theory it is well known that the radiation of printed antennas, can be described well using equivalent magnetic currents. In our previous work [R. T. Maximidis, C. L. Zekios, T. N. Kaifas, E. E. Vafiadis, and G. A. Kyriacou. "Characteristic Mode Analysis of Composite Metal-Dielectric Structure, based on Surface Integral Equation/Moment Method.", 8th European Conference on Antennas and Propagation, April 06-11, 2014.], a new technique was proposed for the characteristic mode computation of composite metal-dielectric structures. Within this effort, the MoM matrix was reformulated by analytically eliminating the other unknowns in order to preserve only the electric current density on the metallic parts of the radiator. Based on this idea in this paper a novel approach for the study of printed antennas exploiting the characteristic modes of equivalent magnetic currents is proposed. As usually, the equivalent magnetic currents are built along the aperture defined between the metallic patch edges and the ground plane. For this purpose the composite metal-dielectric structure is modelled employing a combined field moment method (PMCHW-MoM). The desired equivalent magnetic currents are isolated by an analytical manipulation of the resulting system to yield a corresponding complex admittance matrix. The classical characteristic modes scheme is then employed to yield the side walls (apertures) magnetic eigencurrents. The printed antenna was approximated by a rectangular box with its two large surfaces metallized and equivalent electric currents at its lateral surfaces.

The results were validated by commercial software and is fully consistent with existing analytical solutions for this kind of geometry. The next step considers a realistic arbitrary shaped patch antenna with equivalent magnetic currents along the apertures defined by its edges. A further extension could provide a corresponding design tool.