Near-Field Low Frequency RCS Measurements

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RADAR Cross Section (RCS) is used to describe how an object reflects an incident electromagnetic wave. It is highly dependent on frequency f , or wavelength $\lambda = c/f$. As far as RCS is concerned, the low frequency domain corresponds to frequencies under 1 GHz. In this frequency domain, it is difficult to make measurements that satisfy the Far-Field (FF) assumption due to practical constraints: the incident wave has non planar equiphase surfaces and an inappropriate decay at short ranges. Thus RCS assessments are improved using Near-Field to Far-Field (NF2FF) transforms. Classical NF2FF transforms are almost always high frequency methods and require a bright point model to approximate the target (D.G. Falconer, IEEE Trans. on Ant. Prop., 36 (6), 822-829, 1988 or Birtcher and al, IEEE Trans. on Ant. Prop., 42 (3), 329-334, 1994). Moreover they often refer to Huygens' Principle and tests must be performed on a surface surrounding the Target Under Test (TUT). This kind of requirement is a strong limitation and it is useful, given a set of RCS measurements, to be able to correct errors induced by the Near-Field (NF) conditions.

This work is based on the Characteristic Current Decomposition (CCD) which gives a relevant model of the RCS in the low frequency domain. Characteristic fields associated with the characteristic currents can be seen as eigenmodes; they are derived from the eigenvectors of the Perturbation Operator F (such that $S = I + 2F$, where S is the Scattering Operator). Modes are defined in the same way in the discrete case and can be easily computed with any MoM code. A full FF bistatic RCS matrix is then obtained (which is normal if some attention is paid to energy conservation) and diagonalized in an orthonormal basis made of the desired eigenvectors. In the low frequency case the expansion of the scattered field can be expressed with a few modes and the ORFE algorithm (O. Vacus and al, patent WO/2010/122101, 2010) allows to filter and to extrapolate RCS measurements. Using this decomposition both under the NF and the FF field assumptions, a simple change of basis turns out to be a NF2FF transform (O. Vacus and al, patent WO/2012/171953, 2012).

In our work, NF and FF computations are done with the same in-house code (ARLENE, with a standard Electromagnetic Field Integral Equation). The NF sampling of incident and scattered directions and the number of NF modes are the same as in the FF case but now computed at finite distance. Results will be presented for a NASA-Almond (of length equal to λ) and systems of spheres to study the impact of couplings on the efficiency of the method. Note that scattered fields can be computed without any assumption on the impedance. RAM coating can thus be considered on these targets.