Fast Frequency Sweep for the Computation of Monostatic RCS using the Method of Moments via the Reduced-Basis Method

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The Method of Moments solution to the Electric Field Integral Equation (EFIE) is an accurate and widely used technique to calculate the surface currents and the electromagnetic fields in an object of arbitrary shape. However, even though this technique has been used since long ago, it is still a challange to carry out a fast frequency sweep in the behavior in surface currents and field solutions due to time-consuming EFIE matrix operator filling and its corresponding iterative solution as a function of frequency.

In order to solve this problem, we propose a new methodology to factor out the frequency dependency in the EFIE matrix operator, both in the far field and near field EFIE matrix elements, namely, regular and singular terms. This new approach allows for an efficient Reduced Basis approximation in the EFIE formulation taking frequency as a parameter. This Reduced Basis approximation stands upon the fact that the surface currents vary smoothly as a function of frequency, which allows a reduction in the size of the numerical problem to be solved by identifying the low-dimensional space, namely, Reduced Basis space, where the field solution actually resides. This gives rise to a reduced-order model for fast frequency sweep evaluation of the field solution. Description of this reduded-order model as a linear dynamical system will be studied and discussed in an attempt to understand the physics within the scattering problems under study.

Several Radar Cross Sections of different objects will be computed and shown with, both, this methodology and the traditional one, along with a comparison of the computation times and the errors made within the approximations taken into account.