THE USE OF A HIGHER ORDER BASIS IN COMPUTATIONAL ELECTROMAGNETICS

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ABSTRACT: The objective of this short course is to illustrate the basic principles of a higher order basis in computational electromagnetics. The basic principles will be illustrated through its application in the solution of integral equations and in finite elements. Basically use of a higher order basis not only provides the continuity of the current but also of the charge in an integral equation setting. This results in partial elimination of the breakdown at very low frequency. Also, the number of unknowns to approximate a given problem is dramatically reduced. In addition, the defect at an internal resonant frequency in the analysis of a closed body is highly localized without seriously affecting the solution and therefore one can use an EFIE formulation rather than a CFIE. Typically, for a higher order basis, only 10–20 unknowns per wavelength squared of surface area are needed, leading to a reduction of an order of the magnitude of the size of the impedance matrix that needs to be solved. Hence, problems using the subsectional basis that require a supercomputer to solve can easily be solved on a laptop computer. Also, electrically large problems can easily be handled using modest computer resources, whereas the same problems cannot be solved on large computers using the sub sectional basis because the matrix sizes will be extremely large! For example, if one wishes to analyze a metallic cube with each dimension of four times the wavelength, using 10 subsections per wavelength in a piecewise sub sectional basis will lead to a total of approximately 57,600 unknowns, whereas with the higher order basis, it will use approximately 2700 unknowns and the total solution time on a laptop PC will be less than a minute!

When applying this methodology to the finite element method it will be seen that similar improvement is not only achieved in the computational procedures but also the rate of convergence is highly accelerated. Many other interesting and salient features of the higher order basis are also discussed in this presentation.