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Non-conformal SIE methods: different approaches

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Non-conformal surface integral equation (SIE) methods have received considerable attention from the research community in recent years, in search of procedures to simplify the generation of computer-aided-design (CAD) and mesh models for electromagnetic solution of complex problems or in the context of collaborative projects.

Among the different alternatives, methods based on the use of special basis functions to model nonconforming discretizations are perhaps the most popular approach. These methods do not impose the generation of fictitious surfaces to close the subdomains that are assembled to give rise to a more complex composite mesh. Of these, discontinuous Galerkin (DG) formulations [1] are the ones that have received the most attention, although there are other similar non-Galerkin approaches [2], based on the use of volumetric or surface testing procedures. The previous alternatives usually rely on the application of half-RWG basis functions (also named monopolar-RWG basis functions in [2]), which are non div-conforming basis functions bringing the consequent lack of conditioning (as well as the need to deal with charge accumulations). A different alternative is the use of multibranch RWG basis functions [3]. These functions enjoy the div-conforming property. In return, this formulation is not truly non-conforming, as it is only applicable to quasi non-conformal meshes. Some degree of node conformance is still required.

On the other hand, multitrace methods [4] are a completely different alternative to deal with non-conformal meshed objects. Unlike the previous ones, these are based on the use of conventional RWG basis functions. The cornerstone that allows the solution of non-conformal discretizations with this formulation is the application of the Robin type transmission conditions (RTCs) and the adequate projection between basis functions defined on touching interfaces belonging to independently meshed objects. However, unlike in the DG and similar methodologies, multitrace methods need to be applied on closed subdomains, which may imply the use of fictitious surfaces, artificially increasing the number of unknowns. Furthermore, the number of unknowns at the interfaces separating different regions or independent objects must also be doubled.

In this work we will evaluate different aspects of the different approaches considered related to the versatility, accuracy, and conditioning of the resulting matrix system, in comparison with the conformal reference obtained provided by conventional formulations [5]. The study will be carried out both for perfect electric conductor (PEC) and penetrable objects.

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