STRONGLY ENFORCED WAVEGUIDE PORT BOUNDARY CONDITION AND ITS APPLICATION ON THE ANALYSIS OF OPTICAL DEVICES

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Abstract. An implementation of the Waveguide Port Boundary Condition based on the restriction of the approximation space is presented in the context of a high precision scheme for the numerical analysis of optical devices. In the analysis and design of such devices, often is of interest to analyse the propagation of an electromagnetic field in a domain terminated, or partially terminated, by waveguide cross sections. Moreover, these domains are tipically characterized by curved geometries, subwavelength geometric features and reduced dimensions, which are aspects that, if not carefully treated, can significantly increase the computational cost of such analyses.

The Waveguide Port Boundary Condition[1] is based on the eigenfunction expansion method, in which the set of solutions for a homogeneous PDE, subject to given boundary conditions, is used as to represent the solution of the same PDE when subjected to an arbitrary source. In the current context, the eigenfunctions are chosen as a sufficiently large number of waveguide modes. In the present work, an implementation of such boundary condition based not only on the weak form but also on the restriction of the approximation space is presented. Such implementation results in significant decrease on the degrees of freedom at the boundary, as well as a simplified computational implementation. The efficiency on such boundary condition with respect to the chosen number of modes is also discussed.

The performance of the developed scheme, implemented in the `NeoPZ` framework (`https://github.com/labmec/neopz`), is analysed through numerical examples of increasing complexity, and it is shown that advanced Finite Element techniques present in this framework[2], such as *hp*-refinement, directional refinement and accurate representation of curved geometries, when allied with the aforementioned boundary condition, result in an efficient scheme for the analysis of optical devices.

Keywords: finite elements, high order elements, optical devices, waveguides.

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