A continuation method for building invisible obstacles in waveguides

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We are interested in building invisible obstacles in waveguides, at a given frequency. The invisibility is characterized by the nullity of the scattering coefficients associated to propagating modes. In previous papers, a method has been proposed to prove the existence of invisible obstacles and to build them. Its main drawback was its limitation to small obstacles. In order to get larger invisible obstacles, we have developed a new approach which combines the previous idea with a continuation method: we build a sequence of invisible obstacles, each of them being a small perturbation of the previous one. This relies, at each step, on the ontoness of a differential and on the fixed-point theorem. We have implemented the method in the finite element library XLiFE++, in the case of a penetrable obstacle of a two-dimensional acoustic waveguide in multi-modal regime. A remarkable result is that the ontoness condition can be ensured in many situations, so that the algorithm can be iterated as long as required. Another interesting feature of our approach is that it allows one to prescribe some properties of the obstacle (shape of the obstacle, piecewise constant index, ...), but a drawback is that the algorithm can produce non-realistic negative indices. This is a question that we are currently working on. Finally, let us emphasize that the formalism of the method is very general and flexible. In particular, it can be directly extended to 3D waveguides, or to scattering in free space.

Références

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