Abstract

In recent years the boundary element method (BEM) has become a well established tool for the analysis of acoustic problems involving unbounded domains, such as sound radiation or sound scattering problems. The BEM is based on a boundary integral formulation, which relates the field variables in the solution domain to a set of variables defined on the problem boundary. In this way, only the boundary of the considered problem has to be discretized, which yields relatively small numerical models. However, due to the global nature of the boundary integral formulation, the system matrices are fully populated with complex coefficients and are frequency dependent. Furthermore, since the dynamic boundary variables are expressed in terms of locally defined polynomial shape functions, a large number of elements are required in order to get reasonably prediction accuracy, especially for 3-dimensional problems at higher frequencies. As a result, the use of the BEM is restricted to low-frequency applications.

As an alternative to the element based methods, recently a wave based prediction technique (WBT) has been developed. It is based on an indirect Trefftz approach in that it uses exact solutions of the governing differential equation to approximate the dynamic field variables, instead of simple polynomial functions. As a result, a less fine element discretization is sufficient. This results in smaller numerical models which exhibit an enhanced computational efficiency as compared with the element based methods. The capability of WBT to solve 2D radiation problems has been shown successfully by B. Pluymers in 2006.

This paper discusses the extensions of the WBT for the analysis of sound radiation problems in 3 dimensions. For a class of problems with restricted boundary domains the necessary shape functions to cover the radiation domain outside a spherical envelope of the boundaries are derived. Furthermore, necessary extensions of the numerical integration involved in building the system matrices are investigated. The performance of the method is demonstrated with a numerical example in the frequency range up to 1kHz.