A method of boundary equations for unsteady hyperbolic problems in 3D

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We consider interior and exterior initial boundary value problems for the three-dimensional wave (d'Alembert) equation. First, we reduce a given problem to an equivalent operator equation with respect to unknown sources defined only at the boundary of the original domain. In doing so, the Huygens' principle enables us to obtain the operator equation in a form that involves only finite and non-increasing pre-history of the solution in time. Next, we discretize the resulting boundary equation and solve it efficiently by the method of difference potentials. The overall numerical algorithm handles boundaries of general shape on regular structured grids with no deterioration of accuracy. For long simulation times it offers sub-linear complexity with respect to the grid dimension, i.e., is asymptotically cheaper than the cost of a typical explicit scheme. In addition, our algorithm allows one to share the computational cost between multiple similar problems. On multi-processor (multi-core) platforms, it benefits from what can be considered an effective parallelization in time.