Unique continuation for the wave equation using a discontinuous Galerkin time discretization

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We revisit a unique continuation problem for the wave equation in the time domain which has previously been considered in [1]. In the latter publication this problem has been solved using a full space time discretization. For computational efficiency it would be highly desirable if the time discretization could instead be realized by a discontinuous Galerkin method. This is known to allow for time-marching procedures provided only upwind-type couplings are present in the time discretization. Unfortunately, our investigations show that some stronger couplings in time appear to be necessary to preserve the optimal error estimates shown in [1]. However, by identifying which of those couplings are essential and dropping the others we managed to relax the scheme to an extent where time-marching is at least applicable as a preconditioner. The performance of this preconditioner, which may be interpreted as a forward sweep in the time domain, is illustrated in numerical experiments.

References:

[1] E. Burman, A. Feizmohammadi, A. Münch, L. Oksanen (2021). Space time stabilized finite element methods for a unique continuation problem subject to the wave equation. ESAIM: M2AN, 55, S969– S991.

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