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<tr><th>authors</th><td>Richard LÃ¶scher
Olaf Steinbach</td></tr>
<tr><th>title</th><td>Space-time finite element methods for distributed optimal control of the wave equation</td></tr>
<tr><th>publication_date</th><td>2022-11-04 16:28:27+00:00</td></tr>
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<tr><th>volume</th><td></td></tr>
<tr><th>doi</th><td></td></tr>
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<tr><th>abstract</th><td>We consider space-time tracking type distributed optimal control problems for the wave equation in the space-time domain $Q:= \Omega \times (0,T) \subset {\mathbb{R}}^{n+1}$, where the control is assumed to be in the energy space $[H_{0;,0}^{1,1}(Q)]^*$, rather than in $L^2(Q)$ which is more common. While the latter ensures a unique state in the Sobolev space $H^{1,1}_{0;0,}(Q)$, this does not define a solution isomorphism. Hence we use an appropriate state space X such that the wave operator becomes an isomorphism from X onto $[H_{0;,0}^{1,1}(Q)]^*$. Using space-time finite element spaces of piecewise linear continuous basis functions on completely unstructured but shape regular simplicial meshes, we derive a priori estimates for the error $\|\widetilde{u}_{\varrho h}-\overline{u}\|_{L^2(Q)}$ between the computed space-time finite element solution $\widetilde{u}_{\varrho h}$ and the target function $\overline{u}$ with respect to the regularization parameter ϱ, and the space-time finite element mesh-size h, depending on the regularity of the desired state $\overline{u}$. These estimates lead to the optimal choice $\varrho=h^2$ in order to define the regularization parameter ϱ for a given space-time finite element mesh size h, or to determine the required mesh size h when ϱ is a given constant representing the costs of the control. The theoretical results will be supported by numerical examples with targets of different regularities, including discontinuous targets. Furthermore, an adaptive space-time finite element scheme is proposed and numerically analyzed.</td></tr>
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<tr><th>id</th><td>id6394877869975278933</td></tr>
<tr><th>abstract</th><td>We consider space-time tracking type distributed optimal control problems for the wave equation in the space-time domain Q := â„¦ Ã— (0 , T) âŠ‚ R n +1 , where the control is assumed to be in the energy space [H 1 , 1 0; , 0 (Q)] âˆ— , rather than in L 2 (Q) which is more common. While the latter ensures a unique state in the Sobolev space H 1 , 1 0;0 , (Q), this does not deï¬ne a solution isomorphism. Hence we use an appropriate state space X such that the wave operator becomes an isomorphism from X onto [H 1 , 1 0; , 0 (Q)] âˆ— . Using space-time ï¬nite element spaces of piecewise linear continuous basis functions on completely unstructured but shape regular simplicial meshes, we derive a priori estimates for the error (cid:107) (cid:101) u (cid:37)h âˆ' u (cid:107) L 2 (Q) between the computed space-time ï¬nite element solution (cid:101) u (cid:37)h and the target function u with respect to the regularization parameter (cid:37) , and the space-time ï¬nite element mesh-size h , depending on the regularity of the desired state u . These estimates lead to the optimal choice (cid:37) = h 2 in order to deï¬ne the regularization parameter (cid:37) for a given space-time ï¬nite element mesh size h , or to determine the required mesh size h when (cid:37) is a given constant representing the costs of the control. The theoretical results will be supported by numerical examples with targets of diï¬€erent regularities, including discontinuous targets. Furthermore, an adaptive space-time ï¬nite element scheme is proposed and numerically analyzed.</td></tr>
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