Mathematical control theory of coupled PDEs

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Abstrak

Mathematical control theory for a single partial differential equation (PDE) has dominated the research literature for quite a while, new, complex, and challenging issues have recently arisen in the context of coupled, or interconnected, PDE systems. This has led to a rapidly growing interest, and many unanswered questions, within the PDE community. By concentrating on systems of hyperbolic and parabolic coupled PDEs that are nonlinear, Mathematical Control Theory of Coupled PDEs seeks to provide a mathematical theory for the solution of three main problems: well-posedness and regularity of the controlled dynamics; stabilization and stability; and optimal control for both finite and infinite horizon problems along with existence/uniqueness issues of the associated Riccati equations.
Mathematical Control Theory of Coupled PDEs is based on a series of lectures that are outgrowths of recent research in the area of control theory for systems governed by coupled PDEs. The book develops new mathematical tools amenable to a rigorous analysis of related control problems and the construction of viable control algorithms. Emphasis is placed on the key role played by two interweaving features of the respective dynamical components: (1) propagation of singularities and exceptional "sharp" regularity of the traces of the solutions of the structure's hyperbolic component, and (2) analyticity of the solutions to the parabolic component of the structure, its propagation, and related analytic semigroup (singular) estimates. In addition to providing a mathematical foundation on this topic, this book is useful to engineers and professionals involved in materials science and aerospace engineering in solving fundamental theoretical control problems such as stabilization and optimal control in the context of control systems described by dynamical coupled PDEs. Modern technological applications such as smart materials, interactive systems, and intelligent controls drive further interest in this topic. Included is a wealth of examples based on the structural acoustic model. This comprises a wave equation coupled on the interface with either a plate or a shell equation. This canonical model nonetheless displays a variety of phenomena of interest.