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Robust designâ€"that is, managing design uncertainties such as model uncertainty or parametric uncertaintyâ€"is the often unpleasant issue crucial in much multidisciplinary optimal design work.

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Chapter 2 : Andrew J. Kurdila (Author of Fundamentals of Structural Dynamics)

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Chapter 3 : Robust Optimization-Directed Design - Google Books

Robust design"that is, managing design uncertainties such as model uncertainty or parametric uncertainty"is the often unpleasant issue crucial in much multidisciplinary optimal design work.

Rov, Boundary valuc problems and optimal boundary control for the Navier-Stokes system: Mathematical Modelling and Numerical Analysis, Vol. Control fictitious domain method for solving optimal shape design problems. Fluids, 9, , pp. The purpose of this paper is twofold. First, we provide a short review and summarize results on the robustness of controllability and stabilizability for finite dimensional control problems. We discuss the computation of system radii which provide a measure of robustness. Second, we consider systems which arise as finite difference and finite element approximations to control systems defined by partial differential equations. In particular, we derive controllability criteria for approximations of the controlled heat equation which are easy to check numerically. For a particular example we estabhsh tight theoretical upper and lower bounds on the controllability radii for the finite difference and finite element models and compare these bounds with numerical results. Finally, we present numerical results on stabilizability radii which suggests that conditioning of the LQR control problem may be measured by this radii. Peichl DP control, numerical approximation must be introduced at some point in the modelling process. Finite element, Galerkin and finite difference schemes are typically used to "discretize" continuum models, while in the frequency domain one might construct rational approximations of non-rational transfer functions. For computing purposes, state space models offer certain advantages in that there are numerous computational algorithms well suited for the matrix-linear algebra problems that occur in control design. Direct discretization of continuum models usually produce state space models as do frequency domain approximations followed by realization schemes and model reduction methods such as proper orthogonal decomposition POD. It is fair to say that all approaches have advantages and disadvantages and each approach leads to its own characteristic set of problems. However, to achieve robustness in a design based on approximate models one needs to take into account the robustness of the approximate model with respect to system properties. Given that there are several approaches to constructing finite dimensional state space models, it is reasonable to ask if there is some "measure" that can be used to select the "best" approach for a given system with a specific control design objective. In order to study this problem, it is clear that one must first decide what criteria will be used to determine which state space model is "best" for the particular problem at hand. It is very important to remember that such criteria may change it the system changes, if the control design objective changes or if the numerical method used to solve the corresponding control problem changes. For example, it has been observed [6; 7] that numerical conditioning of the LQR problem can be negatively influenced when non-uniform meshes are used to approximate a DP system governed by a partial differential equation. In this paper we investigate these ideas for distributed parameter systems. We shall focus on a specific subset of these problems. Our goal is to illustrate how one can use system measures to aid in the selection of model reduction and discretization algorithms. In particular, we shall use the concept of "system radii" to measure the "quality" of finite dimensional state space models constructed by direct discretization of continuum models. The motivation for this choice lies in the observation that numerical algorithms for control design can be numerically unstable if applied to systems that are not controllable observable, stabilizable, etc. Moreover, numerical ill-conditioning can result even if the system is controllable and observable but "near" an uncontrollable or unobservable system. This idea is certainly not new and there exist many examples of this type. Demmel [13] has developed a rather nice theory of ill-conditioning and established that numerous problems in numerical linear algebra matrix inversion, eigenvalue calculations and control design pole-placement, robust control all become ill-conditioned if the state space models used in the calculations are close to an ill-posed problem. Laub and his co-workers have established similar results for the LQR problem [18; 29; 30]. Since one of the often noted "advantages" of state space models is their usefulness for computational purposes, it is reasonable to 2 Control System Radii and Robustness Under Approximation 27 use the condition number of the problem as one measure to help select a discretization scheme. One can find a nice presentation of these ideas in the recent book [12] by Datta. Although there are several issues that need to be addressed in the overall approximation process, we shall limit most of our discussion to the study of system radii for systems that typically occur when partial differential equations are discretized by finite element and finite difference schemes. These finite dimensional systems often have nice symmetry properties that can be exploited in the computation of the system radii. The basic problem of preserving system properties under approximation has been addressed by other authors [4; 17; 32] and is crucial to any method. However, we concentrate on the problem of selecting a "good" approximation from the class of all schemes that preserve the appropriate system properties. The paper is organized as follows. We also summarize a few known results concerning these measures and give some new results on computing these measures. This simple example is rich enough to provide some indication of the difficulties one encounters in developing theoretical and computational results for such problems. Finally, we close with a short summary and a simple numerical example to illustrate the potential use of system radii to estimate the numerical condition number of an LQR problem. The following simple example illustrates the type of difficulties that one can encounter.

Chapter 4 : Quality Engineering Using Robust Design - PDF Free Download

The expression "optimization-directed" in this book's title is meant to suggest that the focus is not agonizing over whether optimization strategies identify a true global optimum, but rather whether these strategies make significant design improvements.

Such DAE systems arise, e. The solution of the associated Riccati equation is important, e. Challenges in the numerical solution of the Riccati equation arise from the large-scale of the underlying systems, the algebraic constraint in the DAE system, and the fact that matrices arising in some subproblems may only be marginally stable. A main ingredient in the extension to the DAE case is the projection onto the manifold of the algebraic constraints. In the algorithm, the equations are never explicitly projected, but the projection is only applied as needed. The performance of the algorithm is illustrated on a large-scale Riccati equation associated with the stabilization of Navier-Stokes flow around a cylinder. CVaR is used to model objective or constraint functions in risk averse engineering design and optimization applications under uncertainty. Evaluating the CVaR of the QoI requires sampling in the tail of the QoI distribution and typically requires many solutions of an expensive full order model FOM of the engineering system. Our ROM approaches substantially reduce this computational expense. The resulting CVaR estimation error is proportional to the ROM error in the so-called risk-region, a small region in the space of uncertain system inputs. The second approach uses importance sampling IS. ROM samples are used to estimate the risk region and to construct a biasing distribution. Few FOM samples are then drawn from this biasing distribution. Numerical experiments on a system of semilinear convection-diffusion-reaction equations illustrate the performance of the approaches. Abstract This paper addresses issues that originate in the extension of the Loewner framework to compute reduced order models ROMs of so-called quadratic-bilinear systems. In the linear case, the Loewner framework is data-driven and constructs a ROM from measurements of the transfer function; it does not explicitly require access to the system matrices, which is attractive in many settings. Research on extending the Loewner framework to quadratic-bilinear systems is ongoing. This paper presents one extension and provides details of its implementation that allow application to large-scale problems. Numerical results show the potential of the Loewner framework, but also expose additional issues that need to be addressed to make it fully applicable. Possible approaches to deal with some of these issues are outlined. Abstract This paper introduces an efficient sequential application of reduced order models ROMs to solve linear-quadratic optimal control problems with initial value controls. The numerical solution of such a problem requires Hessian-times-vector multiplications, each of which requires solving a linearized state equation with initial value given by the vector and solving a second order adjoint equation. Projection based ROMs are applied to these differential equations to generate a Hessian approximation. However, in general no fixed ROM well-approximates the application of the Hessian to all possible vectors of initial data. This augmented ROM substantially improves the accuracy of the computed control, but this accuracy may still not be enough. The proposed sequential application of the augmented ROM can compute an approximate control with the same accuracy as the one obtained using only the expensive full order model, but at a fraction of the cost. Abstract This paper presents a new reduced order model ROM Hessian approximation for linear-quadratic optimal control problems where the optimal control is the initial value. Such problems arise in parameter identification, where the parameters to be identified appear in the initial data, and also as subproblems in multiple shooting formulations of more general optimal control problems. The new ROM Hessians can provide a substantially better approximation than the underlying basic ROM approximation, and thus can substantially reduce the computing time needed to solve these optimal control problems. The computation of a Hessian vector product requires the solution of the linearized state equation with initial value given by the vector to which the Hessian is applied to, followed by the solution of the second order adjoint equation. Projection based ROMs of these two linear differential equations are used to generate the Hessian approximation. The challenge is that in general no fixed ROM well-approximates the application of the Hessian to all possible vectors of initial data. This vector is either the right hand side or the vector of initial data to which the Hessian is applied to. Abstract This paper provides a rigorous framework for the numerical solution of shape optimization problems in shell structure acoustics using a reference domain framework. The structure is modeled with Naghdi shell equations, fully coupled to boundary integral equations on a minimally regular surface, permitting the formulation of three-dimensional radiation and scattering problems on a two-dimensional set of reference coordinates. For a class of shape optimization problems existence of optimal solutions under slightly stronger surface regularity assumptions is estiablished. Finally, adjoint equations are used to efficiently compute derivatives of the radiated field with respect to large numbers of shape parameters, which allows consideration of a rich space of shapes, and thus, of a broad range of design problems. A numerical example is presented to illustrate the applicability of the theoretical results. Shape Optimization of Shell Structure Acoustics.

Chapter 5 : Robust optimization-directed design (eBook,) [theinnatdunvilla.com]

Robust designâ€•that is, managing design uncertainties such as model uncertainty or parametric uncertaintyâ€•is the often unpleasant issue crucial in much multidisciplinary optimal design work. Recently, there has been enormous practical interest in strategies for applying optimization tools to the.

Chapter 6 : Publications Â» Stan Uryasev Â» University of Florida

expression in the Robust Optimization-Directed Design title is meant to suggest that the focus is not on agonizing over whether optimization strategies identify a true global optimum, but on whether they make significant design improvements.

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Robust designâ€”that is, managing design uncertainties such as model uncertainty or parametric uncertaintyâ€”is the often unpleasant issue crucial in much multidisciplinary optimal design work. Recently, there has been enormous practical interest in strategies for applying optimization tools to the.

Chapter 8 : Robust Optimization-Directed Design : Michael Zabarankin :

The "Optimization-Directed" expression in the Robust Optimization-Directed Design title is meant to suggest that the focus is not on agonizing over whether optimization strategies identify a true global optimum, but on whether they make significant design improvements.

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