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Scientific Program - Timetable

Sunday 22	Time	Monday 23	Tuesday 24	Wednesday 25	Thursday 26	Friday 27
	9:00		Contributed sessions (15 in parallel)	Plenary Lecture Moritz Diehl	Contributed sessions (15 in parallel)	Contributed sessions (14 in parallel)
	9:30					
	10:00	Registration		von Mises prize lecture		
	10:30					
	11:00		Coffee Break	Coffee Break	Coffee Break	Coffee Break
	11:30		Plenary Lecture Thomas Böhlke	General Assembly	Plenary Lecture Ferdinando Auricchio	Contributed sessions (11 in parallel)
	12:00					
	12:30		Lunch	Lunch	Lunch	
	13:00	Opening				
	13:30	Univ. Chorus Performance				Closing
	14:00	Prandtl Lecture Keith Moffatt	Plenary Lecture Enrique Zuazua	Contributed sessions (15 in parallel)	Plenary Lecture Daniel Kressner	
	14:30					
	15:00	Plenary Lecture Giovanni Galdi	Plenary Lecture Nikolaus Adams		Plenary Lecture Stanislaw Stupkiewicz	
	15:30					
Registration pre-opening	16:00	Coffee Break	Coffee Break Poster session	Coffee Break	Coffee Break Poster session	
	16:30	Minisymposia & Young Reseachers' Minisymposia (10 in parallel)	Contributed sessions (14 in parallel)	Contributed sessions (15 in parallel)	Contributed sessions (15 in parallel)	
	17:00					
	17:30					
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	18:30		Public lecture Francesco D'Andria			
	19:00	Opening reception at Castle of Charles V				
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GAMM 2015

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S16: Optimization

Optimization is the next natural step after simulation with increasing importance in the future. The aim of this session is to provide the basis of a holistic overview of all areas of optimization. Thus abstracts from both a theoretical as well as an applied perspective are welcome.

Construction of a Magnet as an Absolute Positioning Scale

Aleksandar Mojsic, Joanna Sokoł, Marina Ludszuweit, Armin Fügenschuh
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We consider the problem of measuring distances to a high precision, that is, on a micrometer resolution over a length of several meters. Several techniques are currently in use, such as optical, electronic, mechanical. We focus on magnetic scales. Hereto, a ferromagnetic stripe is magnetized by a certain pattern. Then a sensor head, consisting of a number of Hall cell elements, is reading the field strength. Based on this information, the goal is to determine the position on the scale. Two different principles are in use, the incremental and the absolute positioning systems. For an incremental measurement of a position, the sensor must start in a defined initial position, and from there it moves to the desired position, while the sensor logic counts the number of polarization changes on the stripe. Such systems are easy to construct, but have the disadvantage that the sensor always needs to start from its initial position, which makes such systems slow and inflexible for certain applications. Here, absolute positioning systems are favorable, which are able to determine the correct position from the local magnetic information. In the present state-of-the-art, such system come, for example, with two parallel magnetic stripes and rather large sensor heads, which makes the production of such systems more expensive and also limits their range of potential applications.

To overcome the current difficulties of absolute positioning systems, we develop a new magnetic encoding scheme together with a corresponding position computing logic. In this new approach, the angles between the individual poles on the stripe are no longer only perpendicular (as they are in the currently used rulers), but deviate from this within some bounds. Hence we can use a larger variety of angles to encode further information on the absolute position. The magnetic poles are thus not squares or rectangles, but trapezoids in general. A specially constructed sensor, developed by our industrial partner, is used to read the magnetic field signal. On this sensor, a number of Hall cell elements is reading the magnetic ruler. Compared to current absolute positioning systems, this sensor head is much smaller, since we have to read from the same magnetic pole several signals. From these signals, we now reconstruct the absolute position on the ruler.

This engineering problem leads to several mathematical and algorithmic problems. The first issue is the calibration of a hall sensors. Due to small differences during the production process, two Hall cell elements typically measure slightly different values from the same underlying magnetic signal. We overcome this obstacle by solving an overdetermined linear system on the measured data for each Hall cell.

The second issue is the numerical approximation of a magnetic signal on the scale. Finite element codes turned out to be too slow, too time consuming, and too coarse with respect to the solution quality. We achieve the approximation as a linear combination of a certain number of basis polynomial functions of order around 10. This results in an algorithm that is such resource efficient in terms of memory and time, that it is suitable for an implementation an a DSP or FPGA. (This is a research project of its own, conducted by our academic partners at TU Berlin.) We then compute the inverse to the signals, that is, we estimate the position on the scale that is the best-fit to the measured signal data.

The third issue is to construct the scale such that it allows for a unique inverse on each individual position (on a micrometer scale, there are several million positions to be encoded). Hereto we use mixed-integer linear programming, and we use IBM ILOG CPLEX as solving tool. The structure of the scale can be represented by a sequence of trapezoids of the same height that can be glued to create a stripe, therefore we will be looking for such sequence. Magnets as trapezoids, are represented by the lengths of upper and lower bases. Each magnet will be assigned a position-index in the sequence of the trapezoids where it occurs. We use binary variable for every triple $(uplen; lowlen; pos)$ from a given set. The variable is equal to 1 iff a magnet with upper base length $uplen$ and lower base length $lowlen$ is in the position pos. To optimization goal is to find a scale of maximum length that still allows for a unique position determination. The constraints of this optimization problem state that for every magnet the angle between the leg of trapezoid and its base is near $\frac{\Pi}{2}$ and that for the obtained scale we will have unique positions. The first condition can be easily written as a linear constraint. We meet the second condition by dividing the main problem into the problems of creating a few short scales that compose into the final scale. In each short scale we avoid using two magnets consecutively if they were already used in such a way in previous parts. With properly chosen magnet lengths this condition is sufficient (but not necessary) to give the uniqueness in readings of magnetic field. The general optimization task is how to construct the longest possible ruler and to keep the uniqueness of the magnetic pole pattern. At the same time the second best fitting norm should be on a stable distance from zero which provide the stability of the absolute positioning algorithm.

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Control of water reservoirs aeration process

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The mechanical aeration process in water reservoirs is one of the most used techniques to combat eutrophication. It consists of pumping a source of compressed air in the reservoir bottom via injectors in order to create a dynamic and aerate the water by bringing it in contact with the surface air. We focus in this work in the first hand to the direct problem. It concerns the numerical simulation of the resulting two phase water air-bubbles flow. Different models can be used to describe this problem. Using the fact that the water phase is dominant, we use a simplified model in which the water phase is governed by the Navier-Stokes equations and the aeration effects are taken into account through a source term representing the air effect. Our discretization method is based on three dimensional mixed finite element method [1].

In the other hand, we look at the inverse problem: find the optimal injectors location generating the best motion in the fluid with respect to the aeration purpose. Each injector $Inj_k,\ 1 \leq k \leq m$, is modeled as a small hole $\omega_{z_k,\varepsilon} = z_k + \varepsilon\omega^k$ around a point z_k and having an injection velocity u^k_{inj}, where $\omega^k \subset \mathbb{R}^3$ are bounded and smooth domains containing the origin. The optimal injectors location is characterized as the solution to a topological optimization problem. The topological sensitivity analysis is used to solve this problem. The main idea is to compute the asymptotic topological expansion with respect to the insertion of an injector.

To present this method, we consider the case in which Ω contains a single injector having the form $\omega_{z,\varepsilon} = z + \varepsilon\omega$. The topological sensitivity method provides an asymptotic expansion of an optimal design function j of the form:

$$j(\Omega\backslash\overline{\omega_{z,\varepsilon}}) = j(\Omega) + f(\varepsilon)\delta j(z) + o(f(\varepsilon)), \quad \forall z \in \Omega,$$

where $f(\varepsilon)$ is a scalar positive function going to zero with ε. This expression is called the topological asymptotic expansion and δj the topological gradient. In order to minimize the cost function, the best location to insert a small hole in Ω is where δj is the most negative. In fact if $\delta j(z) < 0$, we have $j(\Omega\backslash\overline{\omega_\varepsilon}) < j(\Omega)$ for small ε. The function δj can be used as a descent direction in the domain optimization process.

In order to obtain a topological sensitivity analysis of the used model, which is the Navier-Stokes equations, with respect to the insertion of an injector, we first discretize the model in time using the characteristics method. We obtain at each time step a generalized Stokes problem. In this work, we derive in the first hand a simple topological sensitivity analysis for the generalized Stokes equations [2]. Our analysis is based on the asymptotic behavior of the velocity perturbation caused by the presence of the injector $\omega_{z,\varepsilon}$. This result is then used to the study of the topological sensitivity analysis for the Navier-Stokes problem [3].

The obtained numerical results show the efficiency of the numerical algorithm [2]. Only few iterations are needed to obtain the optimal injectors location. At each iteration we only need to solve the direct and the adjoint problems on a fixed grid.

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Virtual Process Design in Combined Electromagnetic-Classical Forming Processes: Optimization of Current Parameters

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Preceding research showed that the combination of quasi-static deep drawing and high speed electromagnetic impulse forming, as described in [1], can lead to an extension of classical, purely quasi-static forming limits, if the process parameters are carefully adjusted [2]. Moreover, it was indicated that in round cup deep drawing sharper bottom edge radii can be achieved by combining this manufacturing process with electromagnetic impulse forming. In this case, not only the deep drawing parameters, like punch radius and blankholder force, have to be considered, but the parameters describing the triggering current in the electromagnetic part of the combined process have also to be adjusted carefully to avoid material failure.

The pulses usually used in electromagnetic forming are given by decaying sinus waves, where the forming process is only governed by the first half wave. The field produced by the subsequent half waves mainly interacts with the tool, which has two major effects: on the one hand, the temperature increase of the polymer matrix where the tool coil is embedded in causes thermal wear, as recent research [3] shows, on the other hand the stresses resulting from the Lorentz force between the coil windings leads to mechanical wear of the tool. To avoid fast tool deterioration, methods to cut away or damp the subsequent half waves are of major interest [4].

Following the ideas from [5], in this work virtual process design comprising finite element simulation and mathematical optimization is utilized to study in how far sharp pulsed triggering currents can be controlled and adjusted to lead to sharper bottom edge radii in round cup forming. Particularly, an optimum double exponential current pulse is identified. This class of pulses is parametrized as an example for pulses with mono-directed current employed to reduce the wear of the tool coil.

A viscoplastic material model based on the multiplicative decomposition of the deformation gradient in the context of hyperelasticity has been used to model the material behaviour [6] both during deep drawing and in the electromagnetic forming step. It includes all important characteristics as the nonlinear kinematic and isotropic hardening, anisotropy, and ductile damage in the context of continuum damage mechanics. The model is incorporated into the commercial simulation software LSDYNA and, hence, used within the mathematical optimization procedure.

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Methods with Successive and Parallel Approximations of Inverse Operators for the Nonlinear Least Squares Problem

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In this paper, we are concerned with finding the approximate solution of the nonlinear least squares problem [1]:

$$\min f(x) := \frac{1}{2} F(x)^T F(x), \tag{1}$$

where F is a Fréchet differentiable operator defined on $\mathbb{R}^n$ with values on $\mathbb{R}^m$, $m \geq n$.

For solving the problem (1), we propose a Gauss-Newton type method with the successive approximation of the inverse operator

$$x_{k+1} = x_k - A_k J(x_k)^T F(x_k), \tag{2}$$

$$A_{k+1} = A_k[2E - J(x_{k+1})^T J(x_{k+1}) A_k], \; k = 0, 1, 2, ... \tag{3}$$

where $J(x) = F^{'}(x)$; E is an identity matrix; x_0 and A_0 are given initial approximations to the exact solution x^* and to the inverse operator $A^* = [J(x^*)^T J(x^*)]^{-1}$, respectively. The method (2)-(3) consists of two branches, meaning computations of x_{k+1} and A_{k+1} that are executed by turn. The idea and the advantage of the successive approximation of the inverse operator is to construct the approximate solution of the problem (1) without solving a linear system of algebraic equations.

We derive parallel variants of the Gauss-Newton type method (2)-(3) with both synchronous and asynchronous approximations of the inverse operator. Our study is focused on analyzing the convergence of the derived methods as well as on parallel implementations of them. We investigate the local convergence of the sequential and two parallel methods with approximations of the inverse operator under classic Lipschitz conditions. In addition, we examine the convergence order of the proposed methods. As numerical experiments, we carry out a set of standard tests, comparing the studied methods against the well-known Gauss-Newton method. Furthermore, we develop parallel implementations of these methods and present the results of performance scaling on recent shared-memory architectures.

We foresee to apply parallelization techniques –such as the parallel approximation of inverse operator– to the other methods. In particular, we plan to study the two-step Gauss-Newton method [2] as it uses only one inverse over two function evaluations.

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Geometry Optimization of Branched Sheet Metal Structures with a Globalization Strategy by Adaptive Cubic Regularization

Thea Göllner, Stefan Ulbrich
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We consider the geometry optimization of sheet metal structures with webs for increased stiffness. The structures as well as the webs may exhibit curvature and can be produced using the technologies linear flow splitting and linear bend splitting, developed within the Collaborative Research Centre (CRC) 666, and possible additional forming operations like hydroforming.

To describe the mechanical behaviour of the structures the three-dimensional linear elasticity equations are used which leads to a PDE-constrained optimization problem. The geometry of the considered parts is parameterized by means of free form surfaces. We present an algorithm using adaptive cubic regularization as globalization strategy and exact geometry constraints as well as corresponding convergence results. Further, inexactness is introduced in both, the objective function and its gradient. The proposed algorithm is applied to geometry optimization problems for branched sheet metal parts and numerical results for an engineering application example from CRC 666 are given.

Multidimensional parametrization of microcells in two scale optimization with sparse grid interpolation

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We consider structural optimization problems in linear elasticity with locally periodic porous materials consisting of a matrix and soft inclusions. The method of homogenization has proven to be capable of solving such types of problems [1]. To avoid unnecessary computational effort we split this setting into an offline and an online phase. In the former we calculate a catalogue of effective material properties by solving linear elastic problems on a microcell for given sets of parameters. The parameters may for instance describe the shape of a structure inside a cell at the microscopic level. In the optimization process (online phase) at the macroscopic level these precalculated material properties have to be interpolated. However the generation of the material catalogue is very expensive for more than just a few parameters. To overcome this so-called curse of dimensionality we consider an interpolation method using sparse grids [2, 3]. We present numerical results for compliance minimization.

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A staggered approach to structural shape and topology optimization

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This contribution is concerned with the formulation and evaluation of a staggered optimization routine using results from shape and topological sensitivity analysis. To this extent, we interrelate a parameter-free approach to shape optimization and an evolutionary-type element removal procedure that relies on the topological sensitivity [1, 2] as a rejection criterion. As opposed to classical evolutionary-type algorithms in which elements may be removed from the domain boundary as well as from the interior of the domain at the same time, we specify an advancing-front algorithm that is only allowed to remove elements from the existing design boundary of the domain. This process is repeated until the minimum topological sensitivity is no longer encountered at the design boundary but in the interior of the domain. Subsequently, we invoke the traction method [3] for shape variation in order to achieve a more accurate approximation of the true optimal shape for the newly established design boundary. Having obtained the desired layout by shape variation, we create a hole in the interior of the domain by removing all cells that are adjacent to the nodal point that exhibits the minimum topological sensitivity and resume the advancing front algorithm to expand the newly established hole.
To allow for a successful coupling of the element removal procedure and the shape variation phase within a staggered optimization routine the overall outline is subject to geometrical constraints and is accompanied by a boundary smoothing technique.

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On curvature control in node–based shape optimization

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In this work we present and compare three approaches to control of the curvature of the domain boundary in two–dimensional shape optimization. This is of interest with regard to manufacturing constraints [1], for instance in milling processes. In node–based shape optimization the coordinates of the FE nodes are used as design variables. Hence objective and constraint functions have to be formulated in terms of the nodal coordinates. Therefore, we investigate various formulations for the curvature of the domain boundary in terms of the coordinates of the boundary nodes. In addition, the sensitivities of these expressions with respect to the design nodes are required for the application of gradient–based optimization algorithms.
In the first approach, we consider a local representation of the boundary by a smooth curve in arc-length parametrization. After expanding the curve in a Taylor series up to second order a curvature can be assigned to each node depending on the coordinates of its direct neighbors [2]. In the second approach, three neighboring nodes are interpolated by a quadratic polynomial. To ensure definiteness of the polynomial the triple of considered nodes is translated and rotated into a reference system. In the last approach, a NURBS (non–uniform rational B–spline) curve [3] is defined using the FE nodes as control nodes. In contrast to the previous approaches the control nodes are in general not interpolated. Furthermore, the NURBS weights can be used to influence the pathway of the curve towards or away from the control nodes.
All three approaches result in a curvature value for each design node based on the evaluation of the second derivative of the corresponding local approximation. In the context of a constrained shape optimization problem, a constraint aggregation formulation [1] such as the Kreisselmeier–Steinhauser function may be applied.

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Optimizing Extrusion Dies with Profile Shape as an Objective Function

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In the application of plastics profile extrusion, die design is complicated by the rather unintuitive and non-linear behavior of plastics melts. Traditionally, this obstacle is overcome by the experience of the die designer during an arduous cut-and-try process [1, 2]. It has been successfully demonstrated [3, 4], that this design process can be supported by solving an inverse problem with the product shape as input and the die geometry as design vector of an optimization problem. In this optimization problem, the Navier-Stokes-Equations, which govern the flow of the plastics melt through the die, serve as constraints.

Optimization with the aim of balancing the extrusion die, meaning that the objective is a homogeneous outflow velocity distribution, has already been investigated extensively [3, 4, 5, 6]. In the second phase of the Cluster of Excellence "Integrative Production Technologies for High-Wage Countries" at the RWTH Aachen University, an effort is underway to take die swell into account and thus to extend the scope of the numerical shape optimization. The optimization is performed utilizing the in-house flow solver XNS, which uses the finite element method with Galerkin/Least-Squares stabilization, can utilize various parallel machines (IBM Blue Gene, etc.), and is able to exploit the common communication interfaces for distributed-memory systems (SHMEM and MPI). Recently, XNS has been coupled with a nonlinear optimization library [7] in an optimization framework with a geometry kernel utilizing T-Splines, PB-Splines and NURBS.

This talk focuses on die swell and its incorporation into an objective function in the design of extrusion dies. It is investigated how die swell influences the optimization strategy, and first applications using industrial dies are shown.

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Robust optimization of trusses under dynamic loads via nonlinear semidefinite programming

Anja Kuttich, Stefan Ulbrich
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We consider the problem of optimal truss topology design with respect to uncertainty in time-dependent loads via a robust optimization approach. To evaluate the stability and stiffness of truss structures we use the mean square displacement as a suitable objective function, which allows for an efficient calculation of a worst-case scenario. In the dynamic case the static equilibrium conditions must be replaced by a system of ordinary differential equations taking into account Newton's law of motion. Using the H_∞ norm of the transfer-function for the worst-case objective function and the Bounded-Real Lemma the optimal dynamic truss topology design problem can be expressed via nonlinear semidefinite programming. We apply a sequential semidefinite programming method to solve the resulting nonlinear semidefinite programming problem and present numerical results.

About the design of morphing airfoils under uncertainties

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Shape optimization has been widely used in aerospace vehicles design to define the design which provides the best performance given a set of objectives and constraints [1]. In aerodynamics, it has proved effective in the application to fixed-wing aerodynamic design, as well as in the case of helicopter rotor blades. However, in the latter case, many obstacles still refrain a wide employment of optimization techniques, mainly because rotor blades feature a complex aerodynamics, whose prediction requires accurate yet expensive analysis based on Computational Fluid Dynamics. In addition, the flow conditions of each section of the blade are largely variable for two main reasons. First, blades are required to operate with satisfactory performance in extremely different conditions: in hover approximately steady and azimuthally symmetric flow is encountered, whereas forward flight features an unsteady periodically changing flow. In the latter case, the advancing side of the rotor encounters transonic flow condition, while the retreating side is close to stall conditions. Secondly, significant unsteady effects due to the blade dynamics and flexibility, as well as the interaction with vortices and wakes trailed from preceding blades, affect the blade operating conditions. As a result, even when optimization is employed, the aerodynamic performance in the flight envelope may be often sub-optimal. A very attractive solution to this problem is the employment of a morphing blade, that is a blade capable of changing its shape during flight. Morphing rotor design is a challenging and active area of research: recent studies have focused on blades with adaptable span, chord or twist, as well as conformable airfoils [2]. With regard to the latter, airfoil adjustment has been mainly concerned with camber variation for vibration reduction [3] or dynamic stall delay [4].

In such a context the work presents an optimization framework for dealing with morphing airfoils for helicopter rotor blades. With regard to the morphing strategy, a conformable camber line is considered to deal with variable flow conditions encountered in forward flight with the objective of increasing the aerodynamic performance on the advancing and retreating sides of the rotor. The morphing airfoil consists of a conformable camber line which changes over the period of rotation of the blade, while the thickness distribution is held fixed. Another peculiarity of this approach is that the optimal shape is sought to be robust. This means that the optimal design should be designed to cope with the variation in the operating conditions arising both from the assumptions and simplifications introduced in the models at the design stage, and from the numerous sources of uncertainty present in the realistic world. The optimization algorithm is built to seek an optimal design which is less sensitive with respect to changes of the uncertain parameters defining the problem. Taking into account the uncertainty of the modeling variables in the optimization procedure results in a more reliable optimal design, providing satisfactory performance also in off-design conditions. In particular, the optimization method includes a robustness measure of the optimal design, based on the computation of low-order statistics of the fitness function when variations in the operating conditions (arising not only from the assumptions introduced in the models employed in the design stage, but also from the numerous sources of uncertainty present in the realistic world) are considered. Some preliminary studies on this work have tackled this optimization problem without constraints on the evolving airfoil shape. The present contribution is focused on the introduction of a constraint on the thickness distribution, and on the impact of this geometric constraint on the optimization loop. Furthermore, a complete discussion on the airfoil parameterization and its influence on the optimization process will be addressed.

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Robust Design using classical optimization

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One challenge of developing complex products is to account for a high number of interactions between many subsystems, components and requirements. This leads to uncertainties which can often not be quantified. One example is the lack of knowledge, which arises due distributed development processes over several departments or even companies, changing environmental conditions or non-avoidable changes in influencing parameters during the development phase. This contribution shows, how to use classical optimization approaches to deal with these uncertainties. Classical approaches such as Performance Optimization, Robust Design Optimization and Reliability Assessment are often used for developing products, but reveal some major drawbacks if one deals with uncertainties in a very early phase.

For the purpose of developing robust design, Zimmermann and Hoessle [1], see also [2], describe a stochastic approach for finding a box within the solution space, each edge representing an independent parameter interval in the n-dimensional space. This provides space for unavoidable variations due to uncertainties. For maximum robustness the box is required to be as large as possible. The proposed algorithm seeks for intervals of each design parameter, which guarantee that the system reaches the targets specified, i.e. the design constraints. The algorithm is based on Monte Carlo sampling and can handle any non-linear, high dimensional and noisy problem. Although the algorithm can deal with all kinds of input-output-mappings the computational cost is quite high for complex models. Fender [3], describes a different approach for finding a hyper-box within a solution space. His approach is based on simplified physical models for crash applications, simple enough to derive analytical constraints, i.e. the limit state function for feasible designs. Thus, the problem of finding a box within the feasible domain is solved by classical optimization under constraints. Therefore the edges are moved within the feasible region such that the minimum of all parameter intervals is maximized. The approach is advantageous in terms of the computational burden but requires simplified physical models.

The presented approach is based on finding the largest box within the feasible region by using the requirements of the product as constraints. Focus is on describing the solution space mathematically, e.g. by linear regression. The problem of finding the largest box under constraints is solved by an interior point method algorithm. The method is applied to a real world problem for chassis design and the advantages compared to the stochastic approach are shown.

References

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Optimization of the double sided spiral groove thrust bearing: A comparison to approximate analytical solutions

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Reliable high performance bearings are essential in rotordynamics. As speeds and loads are continuously increased the demands on bearing technology grow simultaneously. Optimization of bearing characteristics becomes more important under these circumstances. For hydrodynamic thrust bearings, recently a special design has been presented [1, 2], which is supposed to enhance the load carrying capacity by 60% compared to the best known thrust bearing type [3]. The bearing consists of two spiral grooved surfaces and is therefore called a double sided spiral groove bearing. Early calculations of the bearing performance base on approximate analytical methods.

In order to verify those results, a detailed numerical model of the bearing is presented by the authors. With the help of a particle swarm optimization method, optimal bearing parameters are determined and a comparison is drawn to other thrust bearing designs. It is shown that previously published results overestimate the performance of the double sided spiral groove bearing severly. Performance charts for optimized configurations with respect to load carrying capacity and friction coefficient are delivered.

References

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Multi-criteria optimisation of the vibro-isolation properties

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The paper deals with a methodology of shaping the vibro-isolation properties of suspensions applied in automotive systems. The developed optimization procedure allows to find a Pareto-optimal [1] system configuration for the conflicting vibro-isolating criteria: the isolated body acceleration and the relative displacement of the suspension system. In order to optimize both of the conflicting vibro-isolation criteria, a minimization of the isolated body acceleration (primary criterion) is proposed taking into account the relative displacement of suspension system that is transferred to a nonlinear inequality constraint. The correctness of the proposed methodology is evaluated using experimental research of the best solutions of seat suspension. This research is performed using the semi active and active systems with optimal controller settings. The optimization is performed for the various excitation signals.

References

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