PROCEEDINGS

53. IWK

Internationales Wissenschaftliches Kolloquium
International Scientific Colloquium

Faculty of
Mechanical Engineering

PROSPECTS IN MECHANICAL ENGINEERING

8 - 12 September 2008

www.tu-ilmenau.de

TECHNISCHE UNIVERSITÄT
ILMENAU

Published by
Impressum

Publisher Herausgeber	Der Rektor der Technischen Universität Ilmenau Univ.-Prof. Dr. rer. nat. habil. Dr. h. c. Prof. h. c. Peter Scharff
Editor Redaktion	Referat Marketing und Studentische Angelegenheiten Andrea Schneider
	Fakultät für Maschinenbau Univ.-Prof. Dr.-Ing. habil. Peter Kurz, Univ.-Prof. Dr.-Ing. habil. Rainer Grünwald, Univ.-Prof. Dr.-Ing. habil. Prof. h. c. Dr. h. c. mult. Gerd Jäger, Dr.-Ing Beate Schlütter, Dipl.-Ing. Silke Stauche
Editorial Deadline Redaktionsschluss	17. August 2008
Publishing House Verlag	Verlag ISLE, Betriebsstätte des ISLE e.V. Werner-von-Siemens-Str. 16, 98693 Ilmenau

CD-ROM-Version:

Implementation Realisierung	Technische Universität Ilmenau Christian Weigel, Helge Drumm
Production Herstellung	CDA Datenträger Albrechts GmbH, 98529 Suhl/Albrechts

ISBN: 978-3-938843-40-6 (CD-ROM-Version)

Online-Version:

Implementation Realisierung	Universitätsbibliothek Ilmenau ilmedia Postfach 10 05 65 98684 Ilmenau

Home / Index:
http://www.db-thueringen.de/servlets/DocumentServlet?id=17534

53rd Internationales Wissenschaftliches Kolloquium
Technische Universität Ilmenau
08 – 12 September 2008

B. Künne / G. Rudolph / T. Richard / B. Naujoks / B. Schultebraucks

A multiobjective evolutionary algorithm for designing and optimizing gearshafts

Abstract

The automated design of mechanical components has been an interesting research area during the last years. By this the chair of Machine Elements and the chair of Algorithm Engineering of the Dortmund University of Technology have developed a multiobjective evolutionary algorithm for the design and the computer-aided optimization of a gearshaft.

The design of a gearshaft is based on design principles, the consideration of DIN-standards and the designer's personal experiences in order to meet the requirements and the requested safety. The translation of the experiences into a computer-readable model is quite a significant problem. In addition, a set of conflicting objectives have to be optimized simultaneously, which leads to several solutions for a multiobjective problem. One way to solve this problems is the application of multiobjective evolutionary algorithms which are based on the principles of the natural evolution [1, 2].

The multiobjective optimization problem differs from a singleobjective optimization problem since it contains more than one objective that has to be optimized. The presented algorithm is a version of the SMS-EMOA [3] which is a multiobjective evolutionary algorithm using indicator-based selection, e.g. a solution's dominated Hypervolume in objective space. It has been tested on many real world problems (e. g. optimization of an airfoil [4]) and benchmark problems.

The hypervolume or S-metric [5] is a distinguished quality measurement for solution sets in multiobjective optimization and provides a ranking for solutions, which would be called incomparable according to the principles of Pareto dominance [6]. The used algorithm has various advantages. Using the algorithm to optimize the

gearshaft pursues the mechanical strength and the assembly compatible manufacture. The algorithm incorporates three objectives, the mass and the inertia moment, which have to be minimized, and the factor of safety, which has to be maximized. These objectives are competitive. The algorithm finds different solutions for the gearshaft, which vary in dimensions of the shaft cranks and the bearings. Moreover, none of the found design solutions can be an absolute optimum. From this set of solutions, the design engineer has to choose one gearshaft according to his personal experiences.

With the presented algorithm the design of a gearshaft can be computed, in the future the design engineer will be enabled to find optimized solutions.

References:

[1] Künne, B. and Kloke, U.: Evolutionäre Algorithmen in der Produktentwicklung. ZWF Zeitschrift für wirtschaftlichen Fabrikbetrieb, 94 (1999), Nr. 9/99, pp. 490-492

[2] Künne, B. and Kloke, U.: Evolutionäre Algorithmen unterstützen das Konstruieren. Konstruktion 52 (2000), Nr. 1/2-2000, pp. 32-35.

[3] M. Emmerich, N. Beume, and B. Naujoks: An EMO algorithm using the hypervolume measure as selection criterion. In C. A. Coello Coello, A. Hernández Aguirre, and E. Zitzler, editors, Proc. Evolutionary Multi-Criterion Optimization: 3. Int'l Conference (EMO 2005), volume 3410 of Lecture Notes in Computer Science, pages 62-76, Springer, Berlin, 2005.

[4] B. Naujoks, N. Beume and M. Emmerich: Multiobjective Optimization using S-metric Selection: Application to threedi-mensional Solution Spaces. In: 2005 IEEE Congress on Evolutionary Computation (CEC'2005), Band 2, pp. 1282–1289, Edinburgh, Scotland, 2005.

[5] E. Zitzler and L. Thiele: Multiobjective Optimization Using Evolutionary Algorithms-A Comparative Study. In: Eiben, A. E. (Hrsg.): Parallel Problem Solving from Nature V, pp. 292–301, Amsterdam, 1998. Springer-Verlag.

[6] K. Deb: Multi-Objective Optimization using Evolutionary Algorithms. J. Wiley & Sons, Chichester, UK, 2001.

Authors:

Univ.-Prof. Dr.-Ing. Bernd Künne,
Prof. Dr. Günter Rudolph,
Dipl.-Inform. Boris Naujoks,
Dipl.-Ing. Tim Richard
Dipl.-Inform. Benedikt Schultebraucks
Fachgebiet Maschinenelemente, Fakultät Maschinenbau, Technische Universität Dortmund,
Leonhard-Euler-Str. 5,
44227, Dortmund
Phone: +49 (0)231 / 755-2129
Fax: +49 (0)231 / 755-2740
E-mail: B.Schultebraucks@me.mb.uni-dortmund.de