Adaptronics and Smart Structures

Hartmut Janocha (Editor)

Adaptronics and Smart Structures

Basics, Materials, Design and Applications

Second, Revised Edition

With 432 Figures and 17 Tables

Springer

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Library of Congress Control Number: 2007925681

ISBN 978-3-540-71965-6 2nd Edition Springer Berlin Heidelberg New York
ISBN 978-3-540-61484-5 1st Edition Springer Berlin Heidelberg New York

Springer is a part of Springer Science+Business Media

springer.com

Typesetting and production: LE-TEX Jelonek, Schmidt & Vöckler GbR, Leipzig
Cover: WMXDesign GmbH, Heidelberg

SPIN 12044214 57/3180/YL - 5 4 3 2 1 0 Printed on acid-free paper

Preface to the 2nd Book Edition

The coined word *adaptronics* describes technical fields that have become known internationally under the names smart materials, smart structures or intelligent systems. The term adaptronics was originally formulated by the limited liability company VDI-Technologiezentrum in Düsseldorf, Germany. In the autumn of 1991 the term was sanctioned by a board of independent experts. Initially, the term encompassed all functions of traditional control loops, which are applied to generate adaptive behaviour, i. e. adaptronic systems or structures that adapt automatically to different operating and environmental conditions. Furthermore, in contrast to conventional control loops in which each functional element is a separate component, adaptronics is characterised by multi-functional components. Thus, several application-specific functional elements are embodied in one single component (e. g. a self-sensing actuator), which is preferably integrated into the structure or the system. The intention is to build lightweight adaptive systems and structures to be as simple as possible, with the ultimate goal of reducing the material and energy resources needed for implementation and operation to an absolute minimum.

Given this background it is obvious that apart from the technical requirements for automation, modern functional materials are an essential basis for the successful design and application of adaptronic products. Today, the most well known of these materials are shape-memory alloys, magnetorheological fluids and piezoelectric materials. An old example of an adaptronic product that has been cited numerously are glasses made of photochromic glass. These glasses automatically change the light transmission depending on the surrounding light intensity by performing sensor, actuator and closed-loop control functions for transmission adaptation. Looking to other technical areas, adaptronics has great potential for application in vibration and noise reduction. Fields of application include, for instance, the automotive industry, mechanical engineering, architecture as well as the aerospace industry. Other kinds of application scenarios focus on nature trying to simulate fundamental 'vital functions' by means of adaptronics. One aspect is the ability of biological systems to recognise and automatically correct local disfunctions in their structure. Naturally, this feature is also desirable for technical systems and structures, especially in areas where safety is essential (civil structures, aircraft).

With this book the editor and the publisher have tackled the task of presenting the state of the art of this both fascinating and demanding technological-scientific field. In this 2nd. book edition the contents from the 1st. edition from 1999 have been updated and extended corresponding to the development progress. The outline, which has proven worthwhile, has been maintained: following an introduction describing the aims and the content of adaptronics, subsequent chapters present the ‘scientific pillars’ from the viewpoint of the various basic disciplines involved. Thereafter, important components of adaptronic structures and systems, such as actuators and sensors, are described. The remaining chapters are dedicated to applications of adaptronics in the various technological and biological/medical fields of daily life, and an outlook towards future developments concludes the book.

It is obvious that no one single person can master all the specialist knowledge involved in such a detailed and varied field as adaptronics. Thus, we recognize both a necessity and a great opportunity in bringing together, in a fundamental work, the knowledge and the experience of proven experts from across the range of adaptronic disciplines. The editor is proud of the fact that numerous experts from all over the world have supported him in performing this task. To all of these he expresses his gratitude. It will not escape the attention of the reader that, in their nuances, viewpoints about adaptronics may diverge somewhat. However, this situation is actually both attractive and stimulating. It is also hardly surprising in view of the fact that adaptronics has only begun a few years ago, to establish itself as a discipline in its own right.

With this background in mind, the editor and publisher hope that the 2nd. edition of this book will also become a useful source of information and ideas, which a large number of readers can rely on time and again. Perhaps it will help some readers to discover their interest or their vocation to actively and creatively support the field of adaptronics along its path to maturity.

Finally, the editor would like to thank his co-workers Petra Detemple, Chris May and Andreas Biehl for their untiring help in transferring the manuscripts and figures, which the contributing authors had presented in widely varied forms, into a uniform format. He also thanks the publishing house Springer-Verlag for the appealing outward design of the book.

In conclusion, the editor wants to assure the critical readership that its constructive comments about the conception, content and presentation of this book are welcome and will be taken into consideration, if possible, in future editions.

Saarbrücken, Germany
Juli 2007 *Hartmut Janocha*

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