Book Review

Intelligent Structural Systems, edited by H. S. Tzou and G. L. Anderson. Published by Kluwer Academic Publishers, Boston, MA, 1992. $169.00, 472 pp.

This book is comprised of 11 chapters written by leading experts in the field. The field of intelligent (smart or adaptive) structures is a rapidly growing one that has great potential for shock and vibration, acoustics and noise, as well as aerospace, automotive, civil, and ship structures and mechatronic systems.

Chapter 1, "Introduction to Smart Structures," by G. L. Anderson, A. Crowson, and J. Chandra (Army Research Office), gives a brief introduction to the general subject of smart structures and makes passing mention of some future activities being sponsored by the Department of Defense. There are no equations, illustrations, or references in this chapter.

Chapter 2, "Active Piezoelectric Shell Continua," by H. S. Tzou (University of Kentucky), gives a brief history of piezoelectricity and its application to various structural configurations. Lengthy and detailed equations are derived to describe the motion of piezoelectric general shells. The equations are next reduced to the cases of thick and thin plates, shells of revolution, and spherical, cylindrical, and conical shells. Finally, various sensing and control schemes are described. The chapter gives 50 references to the literature.

Chapter 3, "Piezoelectric Laminates: Theory and Experiments for Distributed Sensors and Actuators," by C. K. Lee (IBM in San Jose), covers much of the same ground as Chapter 2. However, Chapter 3 is limited to laminated piezoelectric plates and gives much more physical information on experimental apparatus and experimental results. This chapter is concluded with 116 literature references.

Chapter 4, "Active Control of NITINOL-Reinforced Composite Beam," by A. Baz, S. Poh, J. Ro, M. Mutua, and J. Gilheany (Catholic University of America), is concerned with the physics and mathematics of shape-memory alloy (NITINOL) as well as a description of experiments and presentation of the experimental results. Applications considered were control of buckling and flow-induced vibrations. The chapter contains 35 figures and 19 references.

Chapter 5, "Electrorheological Fluids—Materials and Applications," by T. G. Duclos, J. D. Carlson, and M. J. Chrzan (Lord Corp.) and J. P. Coulter (Lehigh University), is concerned with the physics and mechanics of electrorheological fluids as well as their application to pumping devices, dampers, engine mounts, and rotary clutches. Experimental data are presented for a sandwich beam with metallic facings and an electrorheological-fluid core. The chapter contains 15 illustrations and nine references.

Chapter 6, "Piezoelectric Wafers for Reducing the Structure Vibrations," by P. Destuynder, I. Legrain, L. Castel, and N. Richard (France), appears to repeat a lot of the material of Chapter 3. However, Chapter 6 places more emphasis on optimal control issues. The chapter contains 22 illustrations and 13 references.

Chapter 7, "Intelligent Sensor Systems for Underwater Acoustic Applications" by T. R. Howarth, V. K. Varadan, and V. V. Varadan (Pennsylvania State University), discusses in some depth two types of intelligent underwater sensors, both of which utilize a piezoelectronic polymer, polyvinylidene fluoride (PVDF or PVF). The first sensor is a surface acoustic wave

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device that can determine the flow characteristics (laminar vs. turbulent) of an external boundary layer. The second sensor is an active acoustic control system used to characterize the external acoustic field in terms of directional acoustic pressure. Some experimental results are presented. There are 15 illustrations and 17 references.

Chapter 8, "Distributed Transducer Design for Intelligent Structural Components," by J. E. Hubbard, Jr. and S. E. Burke (Draper Lab. and MIT), is also concerned with PVF devices. However, here there is more emphasis on design and control issues but no experimental details. There are eight figures and 11 references.

Chapter 9, "Optimal Actuator Placement in Adaptive Precision Trusses," by S. K. Das and S. Utku (Duke University) and G. S. Chen and B. K. Wada (Jet Propulsion Laboratory, CalTech), deals with the theoretical matrix mathematical analysis for optimization of the location of actuators on a large truss-type structure. No results are presented. There are three figures and 12 references.

Chapter 10, "Active Vibration Control of Axially Moving Continua," by B. Yang (University of Southern California) and C. D. Mote, Jr. (University of California, Berkeley), describes the on-line active vibration control of axially moving media, with particular reference to experimental implementation on a bandsaw. The system described uses optical sensing and electromagnetic actuation. Control issues, such as controllability, observability, stabilization, controller design, and time delay associated with noncolocated control, are discussed in fairly detailed fashion. There are eight figures and 32 references.

Chapter 11, "Model Refinement and Damage Location for Intelligent Structures," by D. C. Zimmerman (University of Florida) and S. W. Smith (University of Kentucky), describes recent developments as well as practical issues in structure identification. Then it gives some numerical results for a discrete system and a beam and experimental results for the beam. There are eight figures, 12 tables, and 103 references.

This book should be quite useful to either those just going into the newly emerging field of intelligent structural systems or those already active in the field. The information presented is up to date as of 1991 and the book was copyrighted in 1992.

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