**Control and Cybernetics**

vol. **37** (2008) No. 1

**Book review:**

# FILTERING THEORY WITH APPLICATIONS TO FAULT DETECTION, ISOLATION, AND ESTIMATION

by

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The natural aspiration of man is the best action – optimal in a definite sense. Although optimal control seems to be difficult to apply directly, mainly because of too high a sensitivity of resulting systems to unavoidable identification errors, it constitutes a suitable starting point for creation of various structures of required characteristics. That has in fact become a basis of the fundamental ideas of robust control, in particular the $H_\infty$ concept. The success of this concept led to natural research pertaining to the transposition of results obtained here from input of a dynamical system to the dual problem concerning output: the task of state estimation, and with regards to the ever-present noises and disturbances – filtration. A look at results obtained in the field of $H_\infty$ filtering is presented by the book "Filtering Theory; with Applications to Fault Detection, Isolation, and Estimation" by A. Saberi, A.A. Stoorvogel and P. Sannuti, published by Birkhäuser in 2007. It is worth remembering that A.A. Stoorvogel is the author of one of the leading monographs in the area of $H_\infty$ control [1], presenting the modern and naturally interpreted, albeit significantly more advanced, time approach.

As can easily be guessed from the above, in the reviewed book filtration is not really treated in its classic meaning, known from the basic approach of signal processing, where useful information had to be separated from noise with the help of knowledge of statistical characteristics alone (e.g. Wiener filter), rather, the methodology used stems from the assumption that the signal is generated by a linear dynamical system submitted to various noises and disturbances, and, with output measurement, one should estimate its actual state (Kalman's filter is pioneering in this approach). Under such conditions filters can also be used for related problems, e.g. prediction or smoothing (which can be treated here as delayed filtering). An important case of this concept is also the so-called inverse filtering task, where with knowledge of the dependence between

[1] A.A. Stoorvogel, *The $H^\infty$ Control Problem; a State Space Approach.* Prentice Hall, Englewood Cliffs, 1992.

input and output, and measurements of noise-filled output, one should solve the inverse problem, i.e. estimate the values of intended input independent of noise.

The book under review consists of three parts. The first part is composed of the first six chapters containing mathematical preliminaries, clearly moving from the elementary notions to auxiliary mathematical aspects of the basics of filtration. Chapters 7-13 constitute the main body of work, presenting the concepts of filters optimal in the sense of $H_\infty$ and $H_2$ in various mutations, differing mainly in assumptions made concerning noises and disturbances, for continuous- and discrete-time systems. In each one the considerations generally consist of a theoretical and a methodological part, with suggestions for practical applications. The last two short chapters 14-15 deal with applications of the presented filters in fault detection from the engineering field.

The above two last chapters concerning fault detection introduce an aspect of controversy to the monograph under review. Together they make up 24 pages of 723, or barely 3% of its volume. At the same time, this topic is visibly dominant in the title of the book, as if specially extended as much as possible, albeit with emphasis placed on particular subtopics: fault detection, isolation, and estimation. This is undoubtedly advantageous from a commercial point of view, significantly increasing the circle of potentially interested readers to include those engaged in this dynamically-developing interdisciplinary area. However, it is difficult to say whether such a trick – generally only seen on the covers of airport-fiction – can be considered proper for an advanced scientific monograph.

The book under review will be particularly useful for researchers of theoretical preferences, the doctoral and master level students of mathematical disciplines, especially automatic control, electrical engineering, and information technology, as well as telecommunication and signal processing, and also may prove inspirational for practitioners of a more refined profile and range of possibilities. This publication should find its way into most libraries of the above disciplines, as well as related fields e.g. statistics, economics, bioengineering, operation research, both as a compendium of knowledge and as a monographic reference of a kind for this important and perspective research and applicational field. For the above aspects, "Filtering Theory; with Applications to Fault Detection, Isolation, and Estimation" by A. Saberi, A.A. Stoorvogel and P. Sannuti is definitely worth recommendation.

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Ali Saberi, Anton A. Stoorvogel, Peddapullaiah Sanuti, *Filtering Theory. With Applications to Fault Detection, Isolation, and Estimation.* Birkhäuser Verlag, Basel–Boston–Berlin, 2007. XIV + 723 pages. ISBN-13: 978-0-8176-4301-0. Price: 108 EUR + VAT (hardcover).