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The Review of Ph.D. Thesis "Discrete Wavelet Transform in Linear System Identification" by Ing. Zdeněk Váňa

Reviewer: Prof. Ing. Miroslav Šimandl, CSc.

Significance for Automatic Control and Robotics. System Identification is an important field in Automatic Control and Robotics. Parametric and nonparametric methods in system identification deal with the problem of extracting information about properties of a real dynamical system using the system input and measurements of the system output with the aim to propose a mathematical model of the system. Therefore, the topic of the thesis, the discrete wavelet transform in system identification, is relevant.

Aims. The thesis attempts to achieve the following aims:

1. To perform a comprehensive survey of the methods of exploiting the wavelet transform for system identification
2. To use the wavelet transform in SISO and in MIMO system identification
3. To investigate the utilization of wavelet transform within the continuous-time linear system identification

Reaching of the second and third goals would lead to new results as far as problem formulation and identification methods are concerned.

Contents of the thesis. The text contains 9 chapters. The starting point, Chapter 1, is a brief introduction and motivation. Chapter 2 introduces the main theme of the thesis: the interconnection of wavelet theory and identification of linear systems. The theme is split into several partial goals. The next chapter presents a brief survey of wavelet transform in linear and nonlinear system identification. Chapter 4 describes the wavelet transform and an introduction to linear parameter system identification is given in Chapter 5. Chapter 6 deals with incorporation of wavelets into identification of SISO time invariant linear systems and Chapter 7 incorporates the wavelets into identification of MIMO linear systems. Chapter 8 presents wavelets as modulating functions. Finally, a summary of thesis results is given in Chapter 9.

Fulfillment of the aims and new results. The first goal is acquired in the Chapter 3, where the methods of exploiting the wavelet transform for system identification were presented. The rest of the aims are acquired in Chapters 6-8, where several original results were presented. The main results are the following:

- A new way of incorporation of the wavelet transform into the identification procedure concerning SISO linear systems, Chapter 6, and MIMO linear systems, Chapter 7, was proposed
- Wavelets were shown as modulating functions, Chapter 8.

These results can be used with advantages in cases, where a sufficiently accurate model is required especially at particular frequency ranges or where only a mathematical model of slow or fast subsystems is required. Therefore, they could be interesting for the automatic control community.

Technical correctness and quality of presentation. A positive aspect of the manuscript is an attempt to introduce the individual areas, the wavelet theory and parameter system identification, namely the interconnection of the wavelet theory and the theory of parameter system identification. The description of the areas has however variable quality. Certain statements or derivations are incorrect, e.g.

- page 41. The author claims, that the parameter estimates are biased for the ARX model. It is strange because the noise term in ARX model represents a white noise.
- pages 34, 35. Equations (6.2) and (6.5) are incorrect.

Other comments. The research has been well received in scientific literature. Ing. Váňa is a coauthor of 7 journal papers and 15 papers at international conferences. Most of them are of application character. This level of scientific output is more than is common during doctoral studies.

Conclusion. The text under review presents the interconnection of the wavelet theory and the theory of parameter system identification. The applicant proved good ability of creative scientific work. It is my understanding that this manuscript fulfills the conditions laid down on a Ph.D thesis. I recommend the Ph.D thesis to the defense.

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