An Overview of 2-D State Space System Identification Theory

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Abstract

In this plenary talk a brief overview of 2-D state space system identification theory and its applications will be presented. There is a large body of literature on 2-D systems, ranging from the traditional difference equation type autoregressive moving average (ARMA) models, to nearest neighbor models used in image processing, and then there are the state-space models which include among others, those independently introduced by Roesser-Givone, Fornasini-Marchesini, Attasi, and Kurek. The Roesser model class has also found wide spread applications in iterative learning control and currently represents an active area of research. Since most of the other 2-D state-space models can be transformed into a Roesser model, attention will be given to the Roesser model. There are essentially three types of problems to be addressed here:

1. The purely stochastic case, where only the output is known and the input is assumed to be an unknown 2-D white noise process. This could lead to time/time, space/time, time/space, and space/space models. This model is used in image modeling and texture generation.

2. The purely deterministic case, where both the input and output are assumed to be deterministic and the system is noise-free. Partial differential equations (i.e., a heat exchanger model) fall into this category.

3. The combined deterministic-stochastic case, where the system contains process and measurement noise. This is the most general case within the linear class of 2-D state space models.

Recent research in 2-D system identification theory has led to the use of subspace-based algorithms. These algorithms have been known to be robust to noise in the data, they require a minimum intervention from the user, and are not iterative. However, for the above three Roesser models, there are no known subspace-based algorithms that can identify the general case of a non-separable transfer function. There are still some unanswered questions. An explanation will be given as to why this is a challenging problem, what are the main challenges, and then present a solution that exploits the problem structure. In essence the non-separable problem becomes a structured system identification problem. Examples of the proposed algorithms will be presented.

About the Speaker:

Dr. José A. Ramos is currently the Chair of Computer Engineering at Nova Southeastern University in Florida, where he teaches circuits, computer programming, discrete mathematics, numerical analysis, design and analysis of algorithms, and digital design. His research interests are in the areas of subspace system identification theory and algorithms, applied optimization, multivariate data analysis, image processing, and numerical linear algebra. He has been a visiting researcher at the Katholieke Universiteit Leuven in Belgium, the University of Montpellier II in France, The University of Porto in Portugal, and the University of Padova in Italy.