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An overview of recent developments of response averaging for the treatment of complex linear systems

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Although simple in apparence, linear systems very quickly exhibit complexity when their dimension is increased or when some of their components are random. The difficulties notably include, first, the treatment of the "mid-frequency range" at which neither deterministic techniques such as modal analysis, nor simplified statistical approaches such as statistical energy analysis can be used, or, second, the study of the propagation of uncertainty in some parameters into the behaviour of an ensemble of nominally identical structures, such as cars exiting the same production line. In this paper, we review some recent developments that offer both a fresh view and practical methods to handle these questions through averaging of parametric dynamic systems. The theory is surveyed for both questions of propagation of uncertainty and treatment of the mid- and high-frequency ranges. A particular focus is on Gaussian averaging or filtering, but other averaging or probability density functions are also discussed. A snapshot of the present state of affair is given and future areas of research and applications are highlighted. It is stressed how the link between model reduction, Krylov subspaces and special functions is central both for the theory and its practical and efficient implementation.

Keywords: Model reduction; Propagation of uncertainty, Mid-frequency, High-frequency, Complex systems, Krylov subspaces