A Physical Basis for Empirical Mode Decomposition

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Abstract

Large scale dynamical systems comprised of interacting mechanical, electrical, chemical and/or biological subsystems are generally nonlinear and difficult to characterize from observed time series. Yet, given a sufficiently dense set of sensors, properly measured time series recorded throughout a system contain all information regarding the important dynamics of that system. Empirical mode decomposition (EMD) has been used for several decades to decompose measured time series in terms of intrinsic mode functions (IMFs), which are oscillatory modes embedded in the data that, when summed, fully reproduce the original time series. However, the method is viewed as *ad hoc* and without physical foundation. In recent work, we have shown a correspondence between the analytical slow flows of the dynamical system and the dominant IMFs, which provides a theoretical basis for EMD. A strongly nonlinear dynamical system is considered to demonstrate this correspondence.

Biography

Lawrence Bergman is a professor of aerospace engineering and an affiliate professor of both civil and mechanical engineering at UIUC. He is a Fellow of ASME and an Associate Fellow of AIAA. He is a former editor-in-chief of the ASME Journal of Vibration and Acoustics, and has served or is currently serving on the editorial boards of Probabilistic Engineering Mechanics, the Journal of Vibration and Control, and the Shock and Vibration Digest. He is a past co-recipient of the Norman Medal and State-of-the-Art in Civil Engineering Award, both from ASCE, and a recipient of the Senior Award in Computational Stochastic Mechanics from IASSAR. He is the co-author of a monograph entitled Nonlinear Targeted Energy Transfer in Mechanical and Structural Systems, published in 2008 by Springer-Verlag.