Commun Nonlinear Sci Numer Simulat 19 (2014) 4080–4093

Contents lists available at ScienceDirect

Commun Nonlinear Sci Numer Simulat

journal homepage: www.elsevier.com/locate/cnsns

Detection of quasi-periodic processes in repeated measurements: New approach for the fitting and clusterization of different data

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ARTICLE INFO

Article history:
Received 13 November 2013
Received in revised form 14 April 2014
Accepted 14 April 2014
Available online 24 April 2014

Keywords:
The repeated EPR measurements
The quasi-periodic (QP) process
The generalized Prony's spectrum (GPS)

ABSTRACT

Many experimentalists were accustomed to think that any independent measurement forms a non-correlated measurement that depends weakly from others. We are trying to reconsider this conventional point of view and prove that similar measurements form a strongly-correlated sequence of random functions with memory. In other words, successive measurements "remember" each other at least their nearest neighbors. This observation and justification on real data help to fit the wide set of data based on the Prony's function. The Prony's decomposition follows from the quasi-periodic (QP) properties of the measured functions and includes the Fourier transform as a partial case. New type of decomposition helps to obtain a specific amplitude–frequency response (AFR) of the measured (random) functions analyzed and each random function contains less number of the fitting parameters in comparison with its number of initial data points. Actually, the calculated AFR can be considered as the generalized Prony's spectrum (GPS), which will be extremely useful in cases where the simple model pretending on description of the measured data is *absent* but vital necessity of their quantitative description is remained. These possibilities open a new way for clusterization of the initial data and new information that is contained in these data gives a chance for their detailed analysis. The electron paramagnetic resonance (EPR) measurements realized for empty resonator (pure noise data) and resonator containing a sample (CeO_2 in our case) confirmed the existence of the QP processes in reality. But we think that the detection of the QP processes is a common feature of many repeated measurements and this new property of successive measurements can attract an attention of many experimentalists.

1. Introduction

In nowadays, it becomes evident that with the increasing of complexity of a system at different stages of its evolution, the fundamental and simple (from the mathematical point of view) rules that have been established earlier are difficult to find and then (if they were found) to justify. In order to understand better the behavior of the complex system irrespective to its specific features studied it is necessary to find some *general principles* that govern by a wide class of the complex system studied. Some principles are hidden inside and covered by the interruption of other uncontrollable factors known in

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http://dx.doi.org/10.1016/j.cnsns.2014.04.013