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An intelligent algorithm to study the response of stochastic dynamical system

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I. INTRODUCTION

Random vibration is a common phenomenon that appears in the field of structural engineering systems, especially when a system is excited by a random loading [1–3]. Correspondingly, the response of such stochastic dynamical systems under random excitation is always a hot issue in understanding the structure performance. Generally, the transient or stationary probability density function satisfied by the system response is used to measure the instantaneous and cumulative impact of random excitation on the systems, which is governed by a FPK equation. Therefore, how to solve the FPK equation is a key problem in analyzing the response of stochastic dynamical systems.

II. ABSTRACT PREPARATION GUIDELINES

In this paper, an intelligent algorithm is proposed and applied to solve the stochastic dynamical systems under random excitation. Our attention is focused on the transient solution of the systems under Non-Gaussian excitation. Firstly, we built a neural network by using Logistic probability functions as the basis functions (LBFNN), in which the weighted coefficients are unknown and to be determined. After that, we construct the loss function to be comprised by the constraint from FPK equation and the normalization condition from the weighted parameters. The innovation of our algorithm is that unknown weighted parameters can be obtained by solving a set of algebraic iteration formulas instead of testify by sample data. All results show that this algorithm is not only capable to get transient solutions of the systems under Gaussian white-noise, but also enable us to get the transient solutions in the case of Non-Gaussian excitation.

As an example, Consider a first-order stochastic dynamical system

$$\dot{x} = -\rho x + \tau x^3 - \omega x^5 + \frac{k}{x} + W(t) \tag{1}$$

Where ρ, τ, ω, k are positive parameters, $W(t)$ is a Gaussian white-noise excitation with zero mean-value and constant noise intensity. Fig. 1 shows the transient probability density of the system (1) at different times.

Consider a stochastic dynamical system under stationary Non-Gaussian excitation

$$\dot{x} = c_1 x - c_3 x^3 + \sigma U(t) \tag{2}$$

Where c_1,c_3,σ are constant, $U(t)$ is a stationary Non-Gaussian random process. Fig. 2. displays the transient joint probability responses of the system (2) under stationary Non-Gaussian excitation.

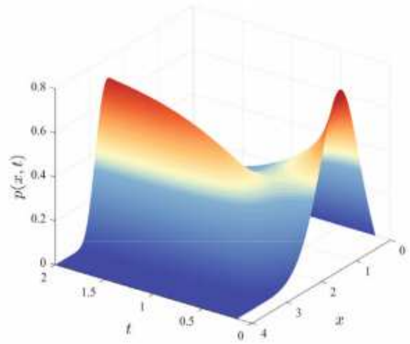

Fig. 1.Transient probability density function of system (1) obtained by LBFNN algorithm under Gaussian excitation

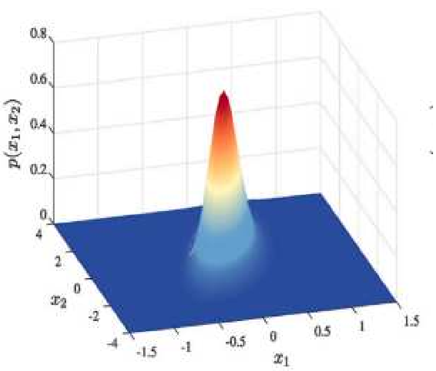

Fig. 2.The transient joint probability responses of the system (2) under stationary Non-Gaussian excitation

III. CONCLUSION

The results show that the LBFNN algorithm can obtain the probability density function at any time for both Gaussian or Non-Gaussian excitation.

IV ACKNOLEGLEMENT

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V REFERENCES

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