Exponential polynomial closure method for dynamical systems under renewal impulse process excitation

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The dynamical system subjected to a renewal impulse process excitation is considered. An Erlang process is assumed as a process driving the impulse process excitation. For such a problem an auxiliary jump process characterized by a Markov chain is introduced and consequently the joint probability density of the state vector and of the underlying Markov states is governed by the coupled set of integro-differential equations [1]. The number of these equations equals the number of Markov states of the auxiliary jump process. This is the generalization of the integro-differential Kolmogorov-Feller equation governing the probability density of the state vector of the dynamical system under a Poisson impulse process excitation. An approximate exponential polynomial closure method is developed for this problem. This method was applied e.g. for non-linear systems under Gaussian white noise excitations [2] and under a Poisson impulse process excitation [3]. The approximate form of the response probability density function is assumed as the exponential function of the polynomial of state variables with time-varying coefficients. The approximate probability density function is inserted into the governing integro-differential which results in the residual functions. It is required that the residuals be orthogonal with respect to suitably chosen trial functions. The result is the set of ordinary differential equations governing the coefficients of the underlying polynomial, which has to be solved numerically. As an example a linear oscillator is considered.

References

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