Research Contributions

It is believed that the research of Professor Ma and his collaborators has advanced the methodology of system analysis and design. Only time can tell what impact, if any, that their research has or will make. In a description of past accomplishments, there are three problem areas to which their contributions are particularly noteworthy.

I. Generalization of Modal Analysis

Together with his students, classical modal analysis was extended to decouple any linear system in real space, using an invertible and nonlinear transformation. As a byproduct, a technique was devised to reduce a damped linear dynamical system to a series of independent single-degree-of-freedom systems. A computer program for system decoupling was also developed. This extension has been applied to streamline design and optimization.

II. Rotating Flow of Thin Films

Together with former students, a new theory of viscous flow of thin layers over a rough rotating surface was developed. Surface roughness was represented as a stochastic process and, using Monte Carlo simulation, it was shown theoretically for the first time that surface roughness played a dominant role in retaining a film on a rotating surface against centrifugation. The theory has been applied to spin coating and lubricant retention.

III. Nonlinear Random Vibration

There are few exact solutions to nonlinear systems. In collaboration with other scholars, exact solutions were constructed for a class of nonlinear stochastic systems. This method of construction constituted a new approach to finding the steady-state response of many random systems. In research into nonlinear damping, relative sensitivity of each control parameters of the differential model of hysteresis was assessed for the first time.

Selected Publications

1. T. K. Caughey and F. Ma, The exact steady-state solution of a class of nonlinear stochastic systems, *International Journal of Nonlinear Mechanics* **17**(3): 137-142, 1982. [Times cited: 88][*]

2. J. H. Hwang and F. Ma, On the flow of a thin liquid film over a rough rotating disk, *Journal of Applied Physics* **66**(1): 388-394, 1989. [Times cited: 57]

3. H. Zhang, G. C. Foliente, Y. Yang and F. Ma, Parameter identification of inelastic structures under dynamic loads, *Earthquake Engineering and Structural Dynamics* **31**(5): 1113-1130, 2002. [Times cited: 73]

4. F. Ma, H. Zhang, A. Bockstedte, G. C. Foliente and P. Paevere, Parameter analysis of the differential model of hysteresis, *ASME Journal of Applied Mechanics* **71**(3): 342-349, 2004. [Times cited: 236]

5. F. Ma, A. Imam and M. Morzfeld, The decoupling of damped linear systems in oscillatory free

[*] Web of Science All Databases citation index

vibration, *Journal of Sound and Vibration* **324**(1-2): 408-428, 2009. [Times cited: 36]

6. J. Liu, W. Wang, F. Ma, Y. B. Yang and C. S. Yang, A data-model-fusion prognostic framework for dynamic system state forecasting, *Engineering Applications of Artificial Intelligence* **25**(4): 814-823, 2012. [Times cited: 131]