NONLINEAR MECHANICS OF DRILLING

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Abstract

Drilling for petro-chemicals is an inherently complex process. From a mechanics standpoint, models of this process are nonlinear in nature. For instance, sources of nonlinearities that can cause undesirable and harmful vibrations in drill-strings include contact between the drill string and bore hole, coupling between axial, torsional, and lateral motions as well as those associated with the drag-bit cutting mechanics. The cutting action is a source of delay effects much like in a metal cutting operation such as milling. Particular to these operations are state-dependent time delays. A combination, of analytical, numerical, and experimental results obtained on drill-string dynamics will be presented. Observed phenomena, which include forward and backward whirling motions and stick-slip dynamics, will be discussed.

Biographical Sketch

Dr. Balachandran received his B. Tech (Naval Architecture) from the Indian Institute of Technology, Madras, India, M.S. (Aerospace Engineering) from Virginia Tech, Blacksburg, VA and Ph.D. (Engineering Mechanics) from Virginia Tech. Currently, he is a Minta Martin Professor of Engineering at the University of Maryland, where he has been since 1993. His research interests include nonlinear phenomena, dynamics and vibrations, and control. The publications that he has authored/co-authored include over ninety journal publications, a Wiley textbook entitled "Applied Nonlinear Dynamics: Analytical, Computational, and Experimental Methods" (1995, 2006), a third edition of a textbook entitled "Vibrations" (2019) by Cambridge University Press, and a co-edited Springer book entitled "Delay Differential Equations: Recent Advances and New Directions" (2009). He holds four U.S. patents and one Japan patent, three related to fiber optic sensors and two related to atomic force microscopy. He serves as a Contributing Editor of the *International Journal of Non-Linear Mechanics*, and an Editor of the *ASME Journal of Computational and Nonlinear Dynamics.* He is a Fellow of ASME and AIAA, and a senior member of IEEE.