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Exploiting noise-induced dynamics for system identification near a Hopf bifurcation[1] MINWOO LEE, The Hong Kong University of Science and Technology, YUANHANG ZHU, Brown University, YU GUAN, LARRY K.B. LI, The Hong Kong University of Science and Technology, VIKRANT GUPTA, Southern University of Science and Technology — We propose a system identification framework that exploits the noise-induced dynamics inherent to nonlinear systems near a supercritical or subcritical Hopf bifurcation. The key assumption made is that the system response can be modeled with a Stuart–Landau equation and its corresponding Fokker–Planck equation. We demonstrate the framework on two different flow systems: a hydrodynamic system (a low-density jet) undergoing a subcritical Hopf bifurcation, and a thermoacoustic system (a Rijke tube) undergoing a supercritical Hopf bifurcation. For both systems, we extract the model coefficients using experimental measurements of the noise-induced dynamics in only the unconditionally stable regime, prior to both the Hopf and saddle-node points. We show that the framework can accurately predict (i) the order of nonlinearity, (ii) the types and locations of the bifurcation points, and (iii) the limit-cycle characteristics beyond such points. As the noise-induced dynamics of nonlinear systems are expected to be universal in the vicinity of a Hopf bifurcation (Ushakov et al. 2005, Phys. Rev. Lett., vol. 95, 123903), the proposed framework should be applicable to a variety of flow systems in nature and engineering.

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Minwoo Lee
The Hong Kong University of Science and Technology

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