Karlsruher Institut für Technologie

Institut für Technische Mechanik
- Dynamik und Mechatronik -

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Bachelor/Master thesis

Robustness analysis of the safe basins of a particle's escape from a quadratic potential well under harmonic excitation with stochastically varying parameters

Background

The escape phenomenon is a classic problem of engineering and natural sciences. The phenomenon occurs whenever a particle or a system of particles leaves a limited potential well and does not return in it. Escape is present at any scales of Physics, from atomic sizes, such as reaction of molecules up to the magnitudes of celestial mechanics, like the collapse of galaxies. Such everyday phenomena as the capsizing of vessels or dynamic buckling of beams are all related to escape dynamics.

At the Institute of Engineering Mechanics (ITM) we investigate several aspects of escape in cooperation with Prof. Gendelman's research group at Technion – Israel Institute of Technology. The simplest escape model consists of a 1DoF mechanical system (see Fig. 1), a particle in a quadratic potential well excited typically with a sinusoidal function:

$$m\ddot{x} + V'(x) = F\sin(\Omega t).$$

For some choice of the parameters and initial conditions, the particle remains in the potential well, for another set of parameters, however, the particle will escape. When depicting the non-escaping set (*safe basin*) in the plane of initial conditions with commensurable excitation frequency/natural frequency ratio, we obtain two distinct regions: a circular, structurally stable part and an unstable one, whose form is influenced by the above frequency ratio, see Fig. 2. However, for the slightest disturbance of the frequency ratio, the unstable part vanishes completely with time.

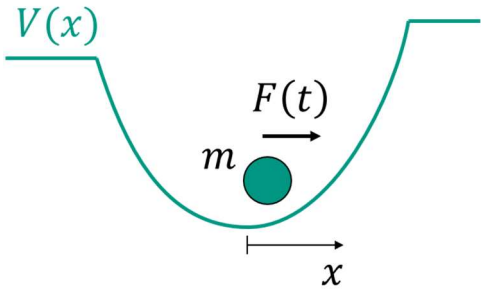

Figure 1 - Escape problem setting

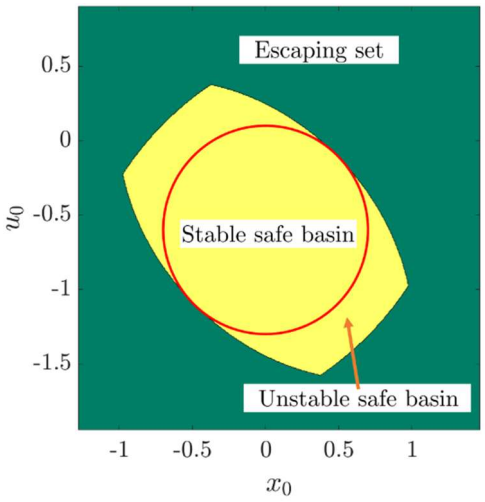

Figure 2 - The partitioning of the safe basin into a structurally stable and an unstable part in the plane of the initial conditions

Topic

The aim of the Bachelor/Master thesis is to determine the effect of the stochastic variation of the excitation parameters F and Ω on the robustness of the safe basin with special focus on the expected value of the escape time.

Requirements

- Strong mathematical background
- Programming skills in MATLAB or in a similar programming language

Start: immediately

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