Poster

Understanding Swaying Motion of Trees using Nonlinear Chimney Model with Realisitic Parameters

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The mathematical models used to study the motion of swaying of trees considered linear and linear restoring forces although it is known that biological systems often yield nonlinear response. The first attempt to include the nonlinear restoring force was by Miller [1]. This work modeled the system as the Duffing's oscillator with restoring force modeled by hard spring and truncated gravitational force. In [2, 3] the work was taken further by considering the whole gravitational term and also end-to-end coupled two segments. In this work, we reconsider this model by considering the biologically inspired parameter values. We carried out some experiments on plants to measure the restoring coefficients and found that it is better modeled as a soft spring. This means the spine of the resonance curve is bent towards lower frequencies. As a result, we find chaotic oscillations for lower frequencies as compared to the hard spring model of Ref. [1]. We have also carried out experiments to study the swaying motion under constant wind and we observed oscillatory motion. However, the model does not show the oscillatory motion for constant forcing implying that there is a fixed point. We have discovered that this fixed point is unstable to addition of small noise leading to limit cycle oscillations. This noise induced bifurcation of the fixed point to the limit cycle explains the oscillatory motion of trees under constant forcing.

References

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