On the dynamics of a collapsing set of blocks

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Abstract

The dynamics of a collapsing stack of rigid blocks is explored in the present paper. Stacks of this type are ubiquitous mechanical systems that can be used to model boxes stacked in warehouses, containers on ships, and stacks of boxes being transported by robots. While studies on the dynamics of a single block moving on a horizontal plane are well known to exhibit complex dynamics when the plane is subject to a harmonic motion, the dynamics of a stack of blocks proves to be far more complex in part because of frictional contacts and impacts between the blocks and the wide range of potential configurations. As analytical methods are untractable to study the dynamics of these systems, recourse to numerical methods is necessary. In the present paper, a non-smooth generalized-alpha method for systems with frictional contact and impact is used to compute the dynamics of the stack. From the simulations, it is shown that high-frequency excitation of the bottom block tends to stabilize a stack. The numerical analyses also reveal the existence of an abundance of distinct solutions stemming from a unique initial configuration when the lowest block in the stack is subject to a harmonic excitation. The abundance of solutions has application to robotics as it illuminates the challenges of controlling the motion of a robot so it can successfully transport a stack of blocks.

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