

Discrete particulate description of elastic structures undergoing geometrically nonlinear deformation and dynamic particle interaction

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June 27, 2022 at 10:00 AM

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ABSTRACT

The mechanical behaviour of deformable bodies in a particulate environment has been an area of increasing interest across a wide spectrum of systems and scale. A composite ensemble of deformable structures and discrete particles involves coupling of component responses, large displacements of structures, and multiple dynamic interactions that lead to inherent contact nonlinearity. This thesis aims to develop a single simulation framework based on the discrete element method (DEM) to describe these structures and their interactions with particles. We build elastically deformable particulate models of slender beams, bistable arches, and thin films and evaluate their geometrically nonlinear response under a variety of loading scenarios. To illustrate the utility of these particulate forms, we first consider a case study of the locomotion of an undulating beam in a particle medium. In another case study, we take up a relatively sparse environment of mobile particles intercepted by an array of sequentially oscillating cantilever beams. We also demonstrate particle-arch interactions in bistable mechanisms that result in particle gripping and trapping. Next, we apply the discrete particulate perspective to model the nucleus of a biological cell and evaluate its response to micropipette aspiration. Taken together, the studies in this thesis facilitate a comprehensive investigation of the particulate approach's efficacy to model a variety of deformable structures, capture geometric nonlinearity in their response, and simulate the interaction dynamics of coupled particle-structure systems.

ABOUT THE SPEAKER

Prasenjit Ghosh is a PhD candidate in the Department of Mechanical Engineering at Indian Institute of Science (IISc), Bengaluru. He obtained his Bachelor's degree from BITS Pilani in 2012 and Master's degree from IISc in 2015. He briefly pursued an industrial stint at Ingersoll Rand and an academic stint at IIM Ahmedabad. His research focuses on discrete particle modeling and its applications in particle-structure interaction problems. He works with Prof. G.K. Ananthasuresh.

