Harkirat Singh

CONTACT INFORMATION

Solid Mechanics
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RESEARCH INTERESTS

Computational Mechanics

EDUCATION

Brown University
Ph.D. in Solid Mechanics — 2018 - present
MS in Solid Mechanics — 2018

Indian Institute of Technology (IIT), Kanpur
Bachelor's and Master's (Dual degree) in Mechanical Engineering — 2016

RESEARCH EXPERIENCE

Graduate Student Researcher — 2018 - present
Advisor: Prof. David Henann
Solid Mechanics, *Brown University*

Research Assistant — 2016-17
Advisor: Prof. Venkatesan
Department of Aerospace, *IIT Kanpur*

Research Assistant — 2015-16
Advisor: Prof. Pankaj Wahi
Mechanics & Applied Mathematics Group, *IIT Kanpur*

TECHNICAL SKILLS

Computational: Finite element analysis, Structural analysis, Numerical methods, Molecular dynamics.

Programming languages: MATLAB, Python, Fortran, C.

Softwares: Abaqus, LAMMPS, Mathematica, Ovito, Maple.

PHD THESIS

Constitutive modeling of size segregation-flow in dense granular materials (May' 18 - Present)

- Formulated constitutive equations for segregation dynamics in bidisperse granular mixtures
- Coupled the model for segregation dynamics with rheological constitutive equations for dense granular mixtures by developing a novel continuum-scale model that enables predictive modeling at large length scales
- Generalized the coupled model in a finite-deformation, elasto-plastic framework which facilitates simulating the segregation/flow dynamics under different loading conditions
- Implemented the coupled continuum framework in the commercial finite-element code Abaqus using a user element (UEL) subroutine
- Used Python scripting in Abaqus to automate several pre/post-processing operations

Discrete element method (DEM) modeling of dense granular mixtures (May' 18 - Present)

- Performed large-scale particle-level simulations which enabled extraction of high fidelity information at small length scales to inform and assess the development of the coupled continuum model for size segregation and flow
- Studied diverse boundary-driven and gravity-driven flows using LAMMPS
- Developed coarse-graining methods to map grain-scale information to continuum-scale

Pressure sensitive shear zones in hydrogel suspensions (May' 22 - Present)
Collaborators: Zohreh Farmani and Joshua Diksman, Wageningen University. Nazanin Ghods, TU Graz

- Used nonlocal continuum modeling to study shear localization in dense hydrogel suspensions in a boundary-driven flow geometry
- Implemented nonlocal granular rheology model using Abaqus UEL subroutine
- Tested model performance against MRI-PIV experimental measurements and DEM simulations

Masters Thesis

Modeling the dynamics of the string vibrating against a rigid obstacle (May '15 - Jul '16)

- Derived the equations of motion for the system using extended Hamilton's principle
- Performed reduced order modeling using Galerkin projection method
- Perfomed stability anaylsis of equations with periodic coefficients using Floquet theory

Selected Projects

Torsional properties of beams with arbitrary cross section (Sep'16 - April'17)

- Studied the discrepancy in torsional frequency of I-beams between FEM and analytical solutions
- Developed series solutions estimating the torsional rigidity of beams with arbitrary cross-section

Exam schedule optimization (Jan'15 - May'15)

- Formulated a well posed linear programming problem with an objective to optimize the exam schedule given number of days, preference of students with other soft and hard constraints.

A Scientific Study of Indian Musical Instruments (May'14 - Jul'14)

- Obtained the mode shapes of Tabla membrane using surface exciter
- Filtered different frequencies and observed their behavior with time in a sound sample of Dotara (Indian stringed musical instrument) using Matlab

Wave Propagation in a finite solid using finite element method (Jan'13 - April'13)

- Implemented finite element formulation in Matlab and calculated nodal displacements
- Analyzed wave propagation due to distributed impulsive force in 2D isotropic solid

Conferences

Society of Engineering Science (SES) Annual Meeting, Texas, US. *Talk*. 2022

Gordan Reserch Conference, Granular Matter, Stonehill college, US. *Poster*. [Poster] 2022

American Physics Society (APS) March Meeting, Chicago, US. *Talk*. [Link] 2022

Society of Engineering Science (SES) Annual Meeting. *Virtual*. [Poster] 2021

9th European Nonlinear Dynamics Conference, Budapest, Hungary. *Talk*. [Paper] 2017

International Congress of Theoretical and Applied Mechanics , Montreal, Canada. [Poster] 2016

International Conference on Structural Nonlinear Dynamics and Diagnosis, Marrakesh, Morocco. *Talk*. [Paper] 2016

International Conference on Advances in Dynamics, Vibrations and Control, NIT Durgapur, India. *Talk*. [Paper] 2016

Journal Publications

Continuum modeling of shear-strain-rate-gradient-driven size-segregation in dense, bidisperse granular flows, with Daren liu and David Henann. *In Preparation*.

Continuum modeling of pressure-gradient-driven size-segregation in dense, bidisperse granular flows, with Daren liu and David Henann. *In Preparation*.

Finite element implementation of segregation dynamics coupled with nonlocal granular rheology , with Shihong Li and David Henann. *In Preparation*

Pressure sensitive non-local behaviour in hydrogel suspension, with Zohreh Farmani, Nazanin Ghods, David Henann and Joshua Diksman. *In Preparation*

Harkirat Singh and Pankaj Wahi. *Non-planar vibrations of a string in the presence of a boundary obstacle*. Journal of Sound and Vibration, 389, 326-349.[PDF]

Harkirat Singh and Pankaj Wahi. *Role of curvatures in determining the characteristics of a string vibrating against a doubly curved obstacle*. Journal of Sound and Vibration, 402, 1-13. [PDF]

Awards / Honors

Poster award at SES conference 2021

President Fellowship at Brown University 2017-20

4 year Doctoral fellowship at UBC (**not pursued*) 2017

Cambridge India Ramanujan Scholarship (**not pursued*) 2017

Teaching Experience

Teaching assistant for Advanced Solid Mechanics (ENGN 1750) (Sep '20 - Dec '20)

Teaching assistant for Mechanics of Solids and Structures (ENGN 0310) (Sep '19 - Dec '19)