

Abhishek Chatterjee

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EDUCATION

Doctor of Philosophy, Mechanical Engineering - August, 2015 - August, 2019

University of Texas at Arlington, Arlington, TX

- Dissertation: “*Modeling and Simulation of Contact and Impact Dynamics in Multibody Systems*”
- Advisor: Dr. Alan Bowling

Master of Science, Mechanical Engineering - August, 2013 - May, 2015

University of Texas at Arlington, Arlington, TX

- Thesis: “*Three-dimensional Indeterminate Impacts in Legged Robotic Locomotion*”
- Advisor: Dr. Alan Bowling

Bachelor of Science, Mechanical Engineering - August, 2009 - May, 2013

Midwestern State University, Wichita Falls, TX

- Minor: Physics and Mathematics
- Senior Design: “*Active Road Rumble Energy Harvesting Panels*”

Graduate Certificate in Unmanned Vehicle Systems - May, 2019

University of Texas at Arlington, Arlington, TX

Relevant Courses: Intelligent Control, Optimal Control of Dynamic Systems, Structural Dynamics, Optimal Estimation of Dynamic Systems, Unmanned Vehicle Systems Development, Introduction to Unmanned Vehicle Systems, Analytical and Computational Dynamics, Design of Digital Control System, Dynamic Systems Modeling and Simulation, Introduction to Robotics, Control Systems, Numerical Analysis

EMPLOYMENT

Postdoctoral Researcher, Tripop Team,

Institut National de Recherche en Informatique et en Automatique (INRIA) and Laboratoire Jean Kuntzman (LJK), Grenoble, Rhône - Alpes, France (Sep 2020 - Current)

Postdoctoral research under the supervision of Dr. Guillaume James and Dr. Bernard Brogliato, on a project related to the analysis of multiple impacts with external loads and study of its effects on the dynamic behavior of granular media.

Engineer - Performance/Simulation/Application, Innovation Technology & Digital Design Division,
Caterpillar .Inc, Mossville - Peoria, IL (Feb 2020 - April 2020)

Application oriented research and development work related to Caterpillar’s *Virtual Product Development* effort that facilitate various internal product groups

Graduate Research Assistant (Data Research and Analysis), Office of the Provost,

University of Texas at Arlington, Arlington, TX (August 2018 - May 2019)

Performed data research and analysis to assist in university policy and decision making.

Graduate Teaching Assistant, Mechanical and Aerospace Engineering Department,

University of Texas at Arlington (August 2015 - May 2018)

Provided feedback to students by grading homeworks and lab reports. Taught lab sections, gave occasional in-class lectures, and conducted office hours to assist in the student’s learning.

Tutor, Department of Mechanical Engineering,

Midwestern State University, Wichita Falls, TX (January 2012 - May 2012)

Tutoring fellow Mechanical Engineering students for freshman-sophomore level classes.

Teaching Assistant, Department of Physics,

Midwestern State University, Wichita Falls, TX (June 2011 - December 2012)

Teaching and grading freshman Physics Labs.

Student Assistant, Department of Mechanical Engineering,

Midwestern State University, Wichita Falls, TX (January 2010 - December 2010)

Preparing lab handouts and setting up lab equipment for Measurement and Instrumentation Lab.

RESEARCH
INTEREST

Multibody Dynamics, Non-smooth/Contact mechanics, Soft/Lightweight Robotics, Artificial Muscles, Legged Locomotion, Rehabilitation Robotics, Non-prehensile manipulation, Musculoskeletal Dynamics, Optimal Control, Reinforcement Learning, Flexible Body Dynamics, FEM

RESEARCH
EXPERIENCE

Tripop Team,

Institut National de Recherche en Informatique et en Automatique (INRIA) and Laboratoire Jean Kuntzman (LJK), Grenoble, Rhône - Alpes, France (Sep 2020 - Current)

- Developing a general analytical formulation for Coefficient of Restitution (COR) between spherical beads under the influence of external load.
 - Asymptotic approximation techniques are used to derive the analytical COR formulation based on a general non-linear viscoelastic model.
 - The COR formulation depends on the material properties of stiffness and damping, as well as parameters representing the effects of external load
- Study of the effects of impacts with external loads on the dynamic behavior of granular media (1D chain) under shock
 - Analytical COR model to be compared against numerical simulation of contact in granular media, in reference to a specific viscoelastic model known as the Kuwabara-Kono model.
 - Qualitative analysis of energy dispersion and traversal of impact wave fronts in granular chains.

Robotics, Biomechanics and Dynamic Systems Laboratory ,

University of Texas at Arlington, Arlington, TX (August 2013 - Jan 2020)

- Modeling and Simulation of Flexible-Body Contact and Impact [*Continuing work, currently inactive, to be resumed in future*]
 - Preliminary work on modeling of contacts and impacts in soft(flexible) multibody systems, based on coordinate partitioning approach.
 - Future goals on this work include employment of eigensolution techniques and development of non-smooth framework for flexible body impacts.
- Force Estimation during (pseudo)-rigid collisions [*in collaboration with Rice University*]
 - Developed a method for determining approximate force and deformation histories during rigid body collisions characterized by an energetic coefficient of restitution.
 - A rigid collision model is augmented with an elastoplastic force model to yield an efficient simulation framework for simultaneous computation of deformation and force histories along with the post-impact states.
- 3D Rigid Surface-to-Surface Contact and Impact Modeling
 - Developed a novel method for modeling surface-surface contacts and impacts in rigid body system that improved upon the various existing models by addressing multi-point stick-slip transition, and guaranteeing system-level energy consistency.
 - The method uses a hybrid dynamic simulation approach where a coordinate partitioning based constraint enforcement method is used to simulate the free and contact constrained dynamics and an energetically consistent impact model is to reset the states upon collision detection.
- Planar Rigid Body Contact and Impact Modeling
 - Developed a planar model for multi-point collision was developed for rigid body system
 - A method for transitioning between contact and impact, in a hybrid dynamic simulation setting, for chatter (Zeno phenomenon) avoidance
 - Planar contact and impact model developed here is being used to study rocking response of structures subjected to seismic excitation.
- Simulation of ATLAS bipedal robot while modeling foot-ground collisions
 - Applied a 3D multi-point collision modeling technique to model and simulate the walking motion of ATLAS bipedal robot.

Department of Mechanical Engineering,

Midwestern State University, Wichita Falls, TX (May 2011 - May 2013)

- Mathematical modeling and prototyping of Rumble-Strip Energy Harvester [*Senior Design Project*]
 - Developed mathematical model of a rumble-strip based energy harvesting system
 - Design optimization to maximize energy output and prototyping a working model
- Campus Energy Study [*as a part of UGROW program*]
 - A feasibility study on various energy harvesting technologies to be implemented on Midwestern State University campus

TEACHING &
MENTORING
EXPERIENCE

Mechanical and Aerospace Engineering Department,

University of Texas at Arlington

(August 2013 - August 2019)

- *Teaching Assistantship* : Assisted students outside class during office hours, provided feedback and evaluation, taught lab-sections and occasionally provided in-class lectures. List of courses taught:
 - MAE 2323 - Dynamics (undergraduate)
 - MAE 3324 - Structure and Mechanical Behavior of Materials (undergraduate)
 - MAE 4345 - Introduction to Robotics (undergraduate)
 - ME/AE 5338 - Analytical and Computational Dynamics (graduate)
 - ME/AE 5305 - Dynamic Systems Modeling and Simulation (graduate)
- *Mentoring*: Co-mentored undergraduate students on Honors project and extracurricular research projects, and master's level graduate students on their thesis projects. Mentees included students from underrepresented backgrounds (Women engineers, US-Army veteran/McNair Scholar, African & Hispanic heritage engineers).

Department of Mechanical Engineering & Department of Physics,

Midwestern State University

(August 2013 - August 2019)

- *Teaching Assistantship* : Taught lab sections for freshman Physics courses: PHYS 1624 - Mechanics, Wave Motion, and Heat and PHYS 2644 - Electricity, Magnetism and Optics. Prepared handouts and lab setups for ME 3123 Measurements and Instrumentation.
- *Tutoring*: Tutored mechanical engineering students outside class on freshman-sophomore level courses.

SERVICES &
VOLUNTEERING

- Peer review for *ASME Journal of Applied Mechanics*, *Nonlinear Dynamics* and *ASME IDETC/CIE* (2015, 2018 & 2019).
- Organizing MAE Brown Bag Seminars, which are weekly seminars held at the Mechanical and Aerospace Engineering Department, at University of Texas at Arlington.
- Volunteer work on behalf of *Graduate Student Senate* at University of Texas at Arlington and student chapters of *ASME*, *ESW* and *NSBE* at Midwestern State University.
- Advising incoming freshman and high-school students during engineering open-house events at University of Texas at Arlington and Midwestern State University.

HONORS &
AWARDS

- Lawrence W. Stephens Endowed Scholarship, University of Texas at Arlington June 2019
- Summer Dissertation Fellowship, University of Texas at Arlington June-August 2019
- STEM Doctoral Fellowship, University of Texas at Arlington 2015-2019
- Mechanical and Aerospace Engineering STEM Fellowship, University of Texas at Arlington 2015-2019
- ASME 2018 MSNDC Conference Student Travel Grant October 2018
- Nominated as a finalist to MSNDC *Best Student Paper Competition* at ASME IDETC/CIE 2018 July 2018
- *Academic Honor Societies*: Pi Mu Epsilon (2011), Alpha Chi (2011), Alpha Lambda Delta (2010), and Phi Eta Sigma (2010)
- *Honor Roll*: Midwestern State University President's Honor Roll (2009), Dean's Honor Roll (2010), and Provost's Honor Roll (2012)
- *Scholarships*: McCoy School of Engineering Scholarship (Fall, 2009 - Spring, 2013), MSU UGROW scholarship (Summer 2011)

SKILLS

Technical: Multibody Dynamics, Contact and Impact Dynamics, Kinematics, Classical and Optimal Control Techniques, Static/Dynamic Optimization, Numerical Method
Computer: C/C++, Python, MATLAB/Simulink, SolidWorks, LabView, NASTRAN, TomSim, Dynasty, Eigen, RBDL
Hardware: NI myRIO, NI DAQ, Arduino

PUBLICATIONS

Journal

1. **Abhishek Chatterjee**, Guillaume James, and Bernard Brogliato. "Approximate coefficient of restitution for nonlinear viscoelastic contact with external load". *Granular Matter* (Under Review).
2. **Abhishek Chatterjee**, Rashi Jain, and Alan Bowling. "Modeling and Simulation of Rocking Block Dynamics subjected to Base Motion using an Energetic Restitution Law". *Journal of Earthquake*

Engineering, 2021.

3. **Abhishek Chatterjee**, Hamid Ghaednia, Alan Bowling and, Matthew Brake. “*Estimation of Impact Forces during Multi-point Collisions involving Small Deformations*”. Multibody System Dynamics, vol. 51, pages 45-90, May, 2021 .
4. **Abhishek Chatterjee**, and Alan Bowling. “*Modeling three-dimensional surface-to-surface rigid contact and impact*”. Multibody System Dynamics, vol. 46, no. 1, pages 1-40, May 2019.
5. **Abhishek Chatterjee**, Adrian Rodriguez and Alan Bowling. “*Analytic solution for planar indeterminate impact*”. Multibody System Dynamics, vol. 42, no. 3, pages 347-379, March 2018.

Conference

1. **Abhishek Chatterjee**, Rashi Jain and Alan Bowling. “*Energetic Contact Modeling For Rocking Block Structures Under Seismic Loading*”. ASME 2021 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference (IDETC/CIE), August 17-22, 2021. Virtual. (Presentation Only)
1. **Abhishek Chatterjee**, Alan Bowling, Hamid Ghaednia and, Matthew Brake. “*Approximate Force History Estimation In Multi-Point Non-Smooth Collisions*”. ASME 2019 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference (IDETC/CIE), August 18-21, 2019. Anaheim, California.
2. **Abhishek Chatterjee** and Alan Bowling. “*Resolving the Unique Invariant Slip-Direction in Rigid Three-Dimensional Multi-Point Impacts at Stick-Slip Transitions*”. ASME 2018 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference (IDETC/CIE), August 26-29, 2018. Québec City, Québec, Canada.
3. **Abhishek Chatterjee** and Alan Bowling. “*Modeling Rigid Body Multi-Point Contact-Impact Transition for Event-Based Simulation*”. 8th ECCOMAS Thematic conference on Multibody Dynamics, June 19-22, 2017. Prague, Czech Republic.
4. **Abhishek Chatterjee** and Alan Bowling. “*Analysis of Three Dimensional Indeterminate Impacts using Rigid Body Constraints*”. 4th International conference on Multibody Dynamics (IMSD), May 29 - June 2, 2016. McGill University, Montreal, Québec, Canada.
5. Adrian Rodriguez, **Abhishek Chatterjee** and Alan Bowling. “*Solution to three-dimensional indeterminate contact and impact with friction using rigid body constraints*”. ASME 2015 International Design Engineering Technical Conference (IDETC/CIE), August 2-5, 2015. Boston, Massachusetts, USA.
6. M. Salim Azzouz, **Abhishek Chatterjee**, Robert Rorabaugh, Christopher Venegas, Krista Duke, John Mark Weller and Chris Smith. “*Active Road Rumble Energy Harvesting Panels*”. ASME 2013 International Mechanical Engineering Congress and Exposition (IMECE), November 15-21, 2013. San Diego, California, USA.

Research Report

1. **Abhishek Chatterjee**, Guillaume James, and Bernard Brogliato. “*Approximate analytical coefficient of restitution formulation for single bead impact with external load, using nonlinear visco-elastic model*”. [Research Report] INRIA Grenoble-Rhone-Alpes, 2021, <https://hal.inria.fr/hal-03462750/>.

Dissertation/Thesis

1. **Abhishek Chatterjee**. “*Modeling and Simulation of Contact and Impact Dynamics in Multibody Systems*”. Dissertation & Theses University of Texas - Arlington; ProQuest Dissertation & Theses Global.
2. **Abhishek Chatterjee**. “*Three-dimensional indeterminate impacts in legged robotic locomotion*”. Dissertation & Theses University of Texas - Arlington; ProQuest Dissertation & Theses Global.

PRESENTATIONS

Oral

- “*Approximate coefficient of restitution for nonlinear visco-elastic contact with external load*”. Tripop Seminars, INRIA, Grenoble, France, 2021.
- “*Energetic Contact Modeling For Rocking Block Structures Under Seismic Loading*”. ASME IDETC/CIE 2019, Virtual, 2021.
- “*Approximate Force History Estimation In Multi-Point Non-Smooth Collisions*”. ASME IDETC/CIE 2019, Anaheim, California, 2019.
- “*Resolving the Unique Invariant Slip-Direction in Rigid Three-Dimensional Multi-Point Impacts at*

Stick-Slip Transitions". ASME IDETC/CIE 2018, Québec City, Québec, Canada., 2018. (**Presented twice: 1 regular conference presentation and 1 competition presentation**)

- "Modeling Surface to Surface Impacts". MAE Brown Bag Seminar Series, University of Texas at Arlington, Arlington, TX, 2017.
- "Resolving Indeterminate, Simultaneous Three-Dimensional Multipoint Contact and Impact with Friction". MAE Brown Bag Seminar Series, University of Texas at Arlington, Arlington, TX, 2016.
- "Solutions to Three-Dimensional Indeterminate Contact and Impact with friction using Rigid Body Constraint". ASME IDETC/CIE, Boston, MA, 2015.
- "Three-Dimensional Indeterminate Impacts in Legged Robotic Locomotion", MAE Brown Bag Seminar Series, University of Texas at Arlington, Arlington, TX, 2015.
- "Humanoid Robot Locomotion". MAE Brown Bag Seminar Series, University of Texas at Arlington, Arlington, TX, 2014
- "Active Road Rumble Energy Harvesting Panels". IDEA MSU, Midwestern State University, Wichita Falls, TX, 2013
- "Harvesting Energy at MSU". North-Texas Area Student Conference, Midwestern State University, Wichita Falls, TX, 2012.
- "Harvesting Energy at MSU", Texas Academy of Science, Sul Ross University, Alpine, TX, 2012.

Poster

- "Multibody Contact and Impact Analysis and Transition". The 13th Annual Celebration of Excellence by Students (ACES), Symposium, University of Texas at Arlington, Arlington, TX, Fall 2017
- "Three Dimensional Indeterminate Impacts Using Rigid Body Constraints". The 12th Annual Celebration of Excellence by Students (ACES), Symposium, University of Texas at Arlington, Arlington, TX, 2016.

REFERENCES

Dr. Alan Bowling

Associate Professor
Department of Mechanical and Aerospace Engineering
University of Texas at Arlington, Arlington, Texas, USA
Email: bowlina@uta.edu
Relationship to Candidate: *PhD supervisor*

Dr. Bernard Brogliato

Directeur de Recherche (Senior Scientist)
Tripop Team,
INRIA, LJK, Grenoble, Rhône - Alpes, France
Email: bernard.brogliato@inria.fr
Relationship to Candidate: *Postdoc co-supervisor*

Dr. Guillaume James

Professor
ENSIMAG-Grenoble-INP, Tripop Team
INRIA, LJK, Grenoble, Rhône - Alpes, France
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Relationship to Candidate: *Postdoc co-supervisor*

Dr. Matthew Brake

Assistant Professor
Department of Mechanical Engineering
Rice University, Houston, Texas, USA
Email: brake@rice.edu
Relationship to Candidate: *Collaborator*

Dr. Hamid Ghaednia

Research Scientist of Orthopedic Surgery,
Skeletal Oncology Research Group (SORG),
Department of Orthopedic Surgery,
Massachusetts General Hospital,
Harvard Medical School, Massachusetts, Boston, USA
Email: hghaednia@mgh.harvard.edu
Relationship to Candidate: *Collaborator*

Dr. Kamesh Subbarao

Associate Professor
Department of Mechanical and Aerospace Engineering
University of Texas at Arlington, Arlington, Texas, USA
Email: subbarao@uta.edu
Relationship to Candidate: *PhD committee member*

Dr. Ashfaq Adnan

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