JAGAJYOTI PANDA

Assistant Professor Grade-II

National Centre for Disaster Mitigation & Management

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Date of Birth: May 11, 1991

Research Interest

My research interests are primarily focused on the adaptive control for smart base-isolated structures subjected to uncertain ground excitations with an emphasis on analytical and experimental investigations. In particular, I am interested in the following topics:

- Online control of active and semi-active systems via reinforcement learning
- Real-time implementation of learning-based model predictive control using multi-fidelity surrogate model for vibration control of base-isolated structures
- Analytical development of servomechanism-based control strategy for semi-active control of structures with magneto-rheological damper
- Study of H_∞/H_2 based robust tracking efficiency of controller-observer system to time-varying reference inputs and its application for better control of seismic responses of structures
- Continuous monitoring of Railway bridges in India: Instrumentation of sensors, real time data acquisition, design and health assessment

Education

- **Doctor of Philosophy (July 2015 – June 2022)**
  Indian Institute of Technology Kanpur, Uttar Pradesh, India
  Thesis Supervisors: Prof. Samit Ray-Chaudhuri and Prof. Sanjukta Chakraborty
  Specialization: Structural Engineering
  Defense Seminar – 24th June 2022
  Thesis Title: *"Servo-mechanism Based Adaptive Control for Smart Base-isolated Structures Subjected to Uncertain Ground Excitations: Algorithm Development and Experimental verification"*

- **Master of Technology (July 2015 – June 2022)**
  Indian Institute of Technology Kanpur, Uttar Pradesh, India
  Thesis Supervisors: Prof. Samit Ray-Chaudhuri
  Specialization: Structural Engineering
  Defense Seminar – 20th August 2020
  Thesis Title: *"Estimation of Response Reduction Factor and Seismic Vulnerability Assessment of IS Code Designed Reinforced Concrete Frames Considering SSI Effects"*
  Course Work Cumulative Performance Index (CPI): **8.67**/10

- **B.Tech. (August 2009 - May 2013)**

National Institute of Technology Rourkela, Odisha, India

B.Tech Project: FEM Analysis and Design of Vertical Vessel Foundation

Cumulative grade point average (CGPA): **9.04**/10

Post-doctoral Experience

- **Post-Doctoral Fellow, King Abdullah University of Science and Technology (Nov 2023- Dec 2023)**

Project: Effect of drilling parameters and loading rate on wellbore instability

Supervisor: Prof. Thomas Finkbeiner

- **Institute Post-Doctoral Fellow, Indian Institute of Technology (IIT) Delhi (July 2022- Nov 2023)**

Project: (i) Algorithm development and numerical validation of deep reinforcement learning-based active/semi-active control policies.

(ii) Implementation of real-time seismic diagnostic system: Application on a base-isolated building in NCR region.

Supervisors: Prof. Vasant A Matsagar and Prof. Souvik Chakraborty

Experimental and Analytical Research Experience

Active/ Semi-active vibration control of structures using deep leaning techniques: Analytical development and numerical validation

- Deep learning-based robust controller framework to minimize the computational cost of implementing model predictive control (MPC) in real time
- Multi-fidelity surrogate model of a highly nonlinear hybrid base-isolated structure is contemplated to train the learning-based controller

Servomechanism based proportional–integral controller for seismic response control of structures using magneto-rheological dampers: Analytical formulation and a numerical study

- A novel servomechanism based digital control algorithm is proposed with state estimator technique for semi-active control of structures
- This is achieved through a hybrid proportional–integral controller, different from the conventional output or state-based feedback design
- Numerical study is conducted to show the superior performance and stability of the algorithm in comparison to the conventional proportional (state) based techniques

Experimental characterization and sensitivity analysis of hysteresis behavior of MR damper through Bouc-Wen model

- Pre-yield and post-yield hysteresis behavior of MR damper is obtained by performing a series of displacement-controlled tests
- Experimental outcomes of MR damper are modeled through Bouc-Wen model and sensitivity of Bouc-Wen model parameters are studied

Servomechanism based proportional–integral controller for seismic response control of structures using magneto-rheological dampers: Experimental verification with sliding base isolated structure

- Shake table experiments are conducted to verify the proposed semi-active control algorithm in the context of an MR damper system attached to a base isolated structure
- Friction characterization is made considering static and kinetic friction to obtain the behavior of base slider

- Experimental study confirms that the proposed control strategy can be conveniently implemented in digital domain without any time-delay

Robust tracking efficiency of controller-observer system to time-varying reference inputs and its application for better control of seismic responses of structures

- A new full and reduced order proportional-integral controller is developed such that the target tracking or command following problems become generic for a wide range of frequency inputs
- The applicability of the proposed controller in a realistic scenario is studied using a base-isolated building under strong seismic excitation

Continuous monitoring of railway bridges in India: instrumentation of sensors, real time data acquisition, and health assessment

- Development of a continuous monitoring system to monitor the condition of New Jubilee bridge and elevated railway track over viaduct, Rohtak-Gohana section
- This will provide timely signals to the railway authorities for maintenance operations

Innovation and Product Developed

- I have developed a real-time feedback system for the MR Damper using NI Hardware-LabVIEW and Arduino microcontroller-IDE interface for vibration control of structures. The system has been tested in IIT Kanpur Structure Engineering Laboratory for its efficiency. The system has demonstrated good performance in laboratory scale testing.

Journal/Ongoing publications

- **Panda, J.**, Chakraborty, S., and Ray-Chaudhuri, S. (2022), "A novel servomechanism based proportional–integral controller with Kalman Filter Estimator for seismic response control of structures using MR dampers", ***Structural Control and Health Monitoring***, **Wiley Online Library**, 28(10), doi.org/10.1002/stc.2807 (Published)

- **Panda, J.**, Chakraborty, S., and Ray-Chaudhuri, S. (2022), "Development and performance evaluation of a robust suboptimal H_∞ based PI controller-observer system with target tracking for better control of seismic responses", ***Structural Control and Health Monitoring***, **Wiley Online Library**, 29(11), doi.org/10.1002/stc.3084 (Published)

- **Panda, J.**, Raychowdhury P., and Ray-Chaudhuri, S. (2022), "Estimation of response reduction factor for IS code designed reinforced concrete frames considering nonlinear soil-structure interaction effects", ***Structure and Infrastructure Engineering***, **Taylor & Francis Online**, doi.org/10.1080/15732479.2022.2147198 (Published)

- **Panda, J.**, Chopra, M., Matsagar, V., and Chakraborty, S. (2023) "An iterative gradient descent-based reinforcement learning policy for active control of structural vibrations" ***Computers & Structures,*** **Elsevier,** 290, doi.org/10.1016/j.compstruc.2023.107183 (Published)

- **Panda, J.**, Singh, V., Jain, R., and Matsagar, V. (2023), "Seismic performance assessment and benefit-cost analysis of mid-rise reinforced concrete base-isolated building using double-curvature friction pendulum bearings", ***Structure and Infrastructure Engineering,*** **Taylor & Francis Online,** doi.org/10.1080/15732479.2023.2275698 (Published)

- **Panda, J.**, Chakraborty, S. and Ray-Chaudhuri, S. (2024), "Servo-mechanism based PI controller for seismic response control of hybrid base-isolated building: an experimental study", ***Engineering Structures,*** **Elsevier** (Accepted, in press)

- **Panda, J.** and Ray-Chaudhuri, S. (2022), "A novel optimization approach to enhance seismic performance of LRB-isolated steel moment-resisting frames under extreme events", *Current Science*, **Indian Academy of Sciences**, 122(1), doi: 10.18520/cs/v122/i1/ (Published)
- **Panda, J.**, Chakraborty, S., and Ray-Chaudhuri, S. (2021), "Dynamic characterization of a 3-Storey steel moment-resisting building using experimental modal analysis", July-September 2021 issue, *Structural Engineering Digest (SED)*, **IASTRUCTE**, 11(3) (Published)
- **Panda, J.**, Chopra, M., Matsagar, V., and Chakraborty, S. (n.d.) "Continuous control of structural vibrations using hybrid deep reinforcement learning policy" *Expert Systems with Applications,* **Elsevier** (Conditionally accepted, review submitted)
- Adarsh, S., **Panda, J.**, and Ray-Chaudhuri, S. (n.d.) "Development of a high-fidelity and optimal model for magneto-rheological damper by parametric sensitivity analysis" *Probabilistic Engineering Mechanics,* **Elsevier** (Under Review)
- Burnwal, M.L., **Panda, J.*** and Raychowdhury P. (n.d.) "Liquefaction mitigation and enhanced seismic performance of footings on saturated sand with geogrids: an experimental study", *Soil Dynamics and Earthquake Engineering*, *Elsevier* (Under review)

Conference Presentations and Proceedings

- **International Proceedings**

  - **Panda, J.** and Ray-Chaudhuri, S. (2019) "An effective controller-observer technique in digital domain for vibration control of structures", *In Proceedings of EMI International Conference*, 3 -5 July, Lyon, France
  - Adarsh, S., **Panda, J.** and Ray-Chaudhuri, S. (2022) "H_2 based acceleration-strain feedback control of structures subjected to seismic input", *In Proceedings of 4th International Conference on Robotics Systems and Automation Engineering, IEEE*, May 20-22, doi:10.1109/AIRC56195.2022.9836445
  - **Panda, J.**, Adarsh, S., and Chakraborty, S. (2023) "Decentralized H_2-Based Active Control to Suppress the Transient Vibration of Structures", *In Proceedings of XII International Conference on Structural Dynamics, EURODYN*, July 2-5, Delft, The Netherlands
  - Adarsh, S., **Panda, J.** and Ray-Chaudhuri, S. (2023) "Bayesian Updating of the Displacement-Strain Transformation Matrix", *In Proceedings of XII International Conference on Structural Dynamics, EURODYN*, July 2-5, , Delft, The Netherlands

- **National Proceedings**

  - Panda, J. and Ray-Chaudhuri, S. (2017), "Optimum Lead-rubber isolation bearing for varying hazard levels: a numerical study", *In Proceedings of 13th International Conference on Vibration Problems (ICOVP-2017)*, 1-3 December, IIT Guwahati, Guwahati, India

  - Panda, J. and Ray-Chaudhuri, S. (2018), "Seismic fragility analysis of a 4-story SMRF considering the effect of soil-structure interactions" *In Proceedings of 16th Symposium on Earthquake Engineering, Department of Earthquake Engineering*, 20-22 December, IIT Roorkee, India

  - Panda, J., Kumar, P. and Ray-Chaudhuri, S. (2018), "Evaluation of response reduction factor of RC frames through nonlinear dynamic analysis", *In Proceedings of 16th Symposium on Earthquake Engineering*, Department of Earthquake Engineering, 20-22 December, IIT Roorkee, India

  - Panda, J, Chakraborty, S. and Ray-Chaudhuri, S. (2021) "Futuristic applications of robust tracking PI based controller observer system to time-varying reference inputs" *In Proceedings of International Conference on Futuristic Technologies*, 22-24 January, IIT Delhi, India

Honours, Fellowship and Awards

- 2023: Outstanding PhD thesis award from Indian Institute of Technology (IIT) Kanpur

- 2023: Institute Postdoctoral Fellowship from Indian Institute of Technology (IIT) Delhi

- 2015-2020: Received a Teaching assistant fellowship from Ministry of Education (Govt of India) for Doctoral Research
- 2019: Received a travel grant from IIT Kanpur for presenting a paper in Engineering Mechanics Institute (EMI) Conference, Lyon, France
- Qualified the Graduate Aptitude Test in Engineering (GATE) examination with 99 Percentile in 2013 and 2015
- Ranked 4th in a class of 60 at the Department of Civil Engineering NIT Rourkela during undergraduate degree (2009-2013)
- Cited in state board merit list at XII level, Odisha, India in 2008
- Cited in state board merit list at X level, Odisha, India in 2006

Teaching Experience

- **Tutor (2022--2023) 1st semester**
 Indian Institute of Technology, Delhi
 Course: "**Finite Element Methods CVL 757**" – *A Departmental Postgraduate course*
 Tasks: Tutorial classes are taken every week and graded quizzes, midterms and final

- **Tutor (2018--2019) 2nd semester**
 Indian Institute of Technology, Kanpur
 Course: "**Mechanics of Solid ESO 202**" – *An Undergraduate Institute Core course*
 Tasks: Tutorial classes are taken every week and graded quizzes, midterms and final

- **Tutor (2019--2020)**
 Indian Institute of Technology, Kanpur
 Course: *"***Experimental Method in Structural Engineering CE623***" – A Departmental Postgraduate course*
 Tasks: Experimental classes are taken every week and graded quizzes, midterms and final

- **Student Advisement (2015--2022)**
 Indian Institute of Technology Kanpur
 - Co-advised graduate students during their M Tech and MS (by Research) thesis
 - Mentored UG students for projects
 - Helped students with the background knowledge of OpenSees, an open source finite element programme required in their thesis

Job/Project Experience

- **Assistant Manager, Jindal Steel and Power Limited, Angul, India (July 2013-July 2015)**
 Project: Construction of 7 numbers G+11 storey buildings (made of steel & Pre-fabricated Polystyrene Panels)
 Responsibility: (i) Execution planning
  (ii) Quality control
  (iii) Budgeting and bill clearance

- **Senior Student Research Associate, Dean of Research & Development (DORD), IIT Kanpur (Jan 2021-Dec 2022)**

  Project: Continuous monitoring of Sampreeti setu (New Jubilee bridge): Instrumentation, design and health assessment

  Responsibility: (i) Finite element modeling and analysis

  (ii) Instrumentation of sensors and Data acquisition

  (iv) Post-processing to assess the condition of bridge

- **Project Engineer, Office of Dean of Infrastructure and Planning, IIT Kanpur, India (Jan 2022-July2022)**

  Responsibility: (i) Planning and quality control for new construction

  (ii) Structural designing and verification

  (iii) Tender document evaluation

  (iv) Bill clearance for all the construction and maintenance works (civil, mechanical and electrical) in IIT Kanpur

Major Graduate Level Courses

- Advance Mathematics for Civil Engineers
- Digital Control System
- Intelligent System and Control
- Experimental Method in Structural Engineering
- Engineering Mechanics
- Earthquake Engineering
- Advance Geotechnical Engineering
- Finite Element Method in Engineering
- Structural Dynamics
- Vibration Control
- Optimization in Engineering

Computer Background

- **Technical Software**
  - Scientific Analysis: MATLAB, MATHEMATICA, MATHCAD
  - FEM Packages: STAAD, SAP, OpenSees, PLAXIS
  - Used MEScope VES 5.0 (Vibrant Tech ltd) for extracting frequencies and mode shapes
  - Worked with Labview 6.0 and NI based data acquisition system
  - Worked with Arduino microcontroller and software interface
- **Programming Languages:** Python, C, C++, Basic
- **Graphing:** GRAPHER, ORIGIN
- **Drawing:** AutoCAD
- **Word Processor:** Latex, MS Words, MathType
- **Operating Systems:** LINUX, WINDOWS