Santosh Mohan Rajkumar

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Education

- **The Ohio State University** — Columbus, OH
  Ph.D. in Mechanical Engineering — *Aug 2023 - Present*
- **Miami University** — Oxford, OH
  Master of Science in Mechanical Engineering; GPA: 4.0/4.0 — *Jan 2021 - Jun 2023*
  Thesis: *Modeling and Experimental Evaluation of Haptic Rendering in Touch Surfaces Using Multifrequency Electrostatic Actuation*
- **National Institute of Technology Silchar** — Silchar, India
  B.Tech in Electrical Engineering; GPA: 8.21/10 (Junior-Senior GPA: 9.2/10) — *Aug 2013 - May 2017*
  Thesis: *Online time-delay estimation and adaptive compensation for feedback control in networked control systems*

Publications

- **Rajkumar, S.M.**, Singh, K.V. and Koo, J.H., 2023. Modeling and Analysis of a Thin Plate with Multiple Harmonic Excitations for Vibrotactile Touch Display Applications. (Accepted to the ASME IDETC/CIE2023)
- **Rajkumar, S.M.**, Singh, K.V., Yang, T.H. and Koo, J.H., "Modeling and Experimental Evaluation of Haptic Localization Using Electrostatic Vibration Actuators," in IEEE Access, vol. 11, pp. 18582-18589, 2023.
- **Rajkumar, S.M.**, Singh, K.V. and Koo, J.H., 2022, October. Modeling and Analysis of Multiple Electrostatic Actuators on the Response of Vibrotactile Haptic Device. In ASME International Mechanical Engineering Congress and Exposition (Vol. 86625, p. V001T01A004). American Society of Mechanical Engineers.
- **Rajkumar, S.M.**, Chakraborty, S., Dey, R. and Deb, D., 2020. Online delay estimation and adaptive compensation in wireless networked system: an embedded control design. International Journal of Control, Automation and Systems, 18, pp.856-866.

Research Experience

- **Department of Mechanical & Aerospace Engineering, The Ohio State University** — Columbus, OH
  Graduate Research Associate (Advisor: Dr. Debdipta Goswami) — *Aug 2023 - Present*
  - **Work in progress**: ....
- **Department of Mechanical & Manufacturing Engineering, Miami University** — Oxford, OH
  Graduate Student Researcher (Advisors: Prof. Kumar Singh & Prof. Jeong-Hoi Koo) — *Aug 2021 - May 2023*
  - **Finite element (FE) modeling of touch displays with spring-damper boundaries**: Developed finite element modeling methods of bar-type and rectangular touch displays with electrostatic vibration actuators providing spring-damper boundaries. Developed in-house MATLAB FE code that can accommodate multi-frequency excitation.
  - **Computationally efficient solution method**: Developed a computationally efficient solution method for dynamic simulation of FE models of the touch displays with harmonic excitation.
  - **Haptic rendering method**: Demonstrated the possibility of positioning haptic feedback on a large touch surface by varying excitation frequencies of electrostatic vibrations actuators both in simulation & experiment.
  - **Prototype fabrication**: Fabricated prototype of a bar-type and rectangular touch display interfaces with multiple electrostatic vibration actuators for experimental validation of the proposed method.
  - **Statistical analysis**: Used statistical and advanced visualization methods in R for the strategic placement of actuators for effective haptic rendering and optimization of actuator mechanical properties.
- **Singh Research Group, Miami University** — Oxford, OH
  Graduate Research Assistant (PI: Prof. Kumar Singh) — *May 2021 - August 2021*
  - **Experimental modal analysis**: Performed experimental modal analysis of hammer vibration test data of 3D printed structures to obtain modal information.
  - **Density-based clustering for determining human bone health**: Performed density-based clustering of modal analysis data of human bone vibration data to determine bone health based on higher modes of damping.
  - **PID controller parameter estimation**: Implemented a PID controller-based optimization method for parameter estimation of a lumped parameter human model.
- **Department of Electrical Engineering, National Institute of Technology Silchar** — Silchar, India
  Undergraduate Student Researcher / Research Assistant (Advisor: Dr. Rajeeb Dey) — *Aug 2016 - May 2017*
  - **Undergraduate Thesis Work**:
    - Proposed a control architecture for real-time time-delay compensation in a wireless networked control system.
    - Proposed a time-delay estimator and an adaptive time-delay compensation scheme for real-time operation.

- Implemented the proposed architecture in the Arduino embedded platform.

◦ **Systems Project Lab**:
- Developed Arduino libraries for matrix operations.
- Implemented numerically stable algorithms for matrix inverse and eigenvalue computation in the Arduino platform.
- Implemented observer-based state-feedback control method to balance an inverted pendulum in the Arduino platform.

Teaching Experience

• **Department of Mechanical & Manufacturing Engineering, Miami University** Oxford, OH
Graduate Teaching Assistant *Jan 2021 - May 2023*

◦ **System Modeling, Analysis, & Control (MME 321)**: Spring 2023
- Grading homework, lab reports, and lab projects. Held office hours. Conducted simulation-based lab sessions. Prepared MATLAB & Simulink-based lab experiments.

◦ **Mechanical Vibrations (MME 315)**: Winter 2023, Summer 2021, Spring 2021
- Graded homework, computational assignments, and projects. Held office hours.

◦ **Control of Dynamic Systems (MME 436/536)**: Fall 2022, Spring 2022, Winter 2022, Fall 2021
- Conducted lab experiments based on the interfacing of Labview with dynamical systems and MATLAB-based simulations. Graded lab reports and lab quizzes.

◦ **Mechanical Workshop (MME Lab)**: Fall 2022, Spring 2022, Fall 2021
- Assisted students from manufacturing methods courses and senior design in conventional machining and 3D printing. Performed periodic maintenance of machinery in the lab.

◦ **Manufacturing Automation (MME 437)**: Spring 2021
- Assisted the instructor in conducting lab sessions. Graded lab reports and assignments.

Industry Experience

• **Indian Oil Corporation Limited (*A Fortune 100 Company*)** Dimapur, India
Senior Engineer *June 2017 - Dec 2020*

◦ **Maintenance**: Performed periodic & preventive maintenance activities for a large petroleum installation's safety automation and electrical systems.

◦ **Inspection**: Performed vibration-based monitoring of machinery and vision-based robotic inspection of petroleum storage facilities.

◦ **Web application development**: Developed web applications for critical information storage using JS, Python, and AWS.

◦ **Purchases & acquisitions**: Handled tendering & negotiations with vendors for purchases. Managed purchases and acquisitions in SAP.

◦ **Training & development**: Handled training & development of a large industrial workforce to ensure safe and standard operating conditions.

Skills Summary

- **Programming & Simulation**: MATLAB, Python, R, JavaScript, C++, Simulink, LabView
- **Libraries & Tools**: numpy, SciPy, Keras, OpenCV, pandas, tidyverse, ggplot2, R Shiny, HTML, CSS3, VueJS, Django
- **CAD & Analysis**: Fusion 360, COMSOL
- **Prototyping, fabrication, & testing**: Milling, lathe, welding, Dremel 3D Printer, Universal Testing Machine
- **Others**: : ROS, Arduino, Linux, Git, NI-cDAQ, Latex, MS Excel

Recent Academic Projects

- **Inverted pendulum balancing with noisy sensor data**: Implemented Kalman filter for state estimation from noisy measurement data and developed an LQR controller.
- **Balance control of a seesaw with a cart**: Mathematically modeled the system using variational mechanics and linearized the non-linear model. Implemented an LQR controller for keeping the see-saw horizontal.
- **Reinforcement learning of a legged robot**: Simulated a 2D walking robot in Simulink. Trained the walking robot for walking using the DDPG method using MATLAB's reinforcement learning toolbox.
- **Distributed control over the web**: Developed simple web pages capable of simulating PID controllers and dynamics of DC motors. Implemented socket communication to remotely control the DC motor models using PID controllers
- **Study of the effect of infill pattern on mechanical strength in 3D printed structures**: Prepared PLA-based rectangular samples using FDM 3D printers with various infill patterns. A flexural bending test was performed on the samples to obtain mechanical strengths. The results from the flexural test are validated using experimental modal analysis of the samples.
- **Search and Classifiers**: Implemented min-conflicts search algorithm to solve the N-Queens problem in MATLAB with visualization. Implemented a naive Bayes spam filter based on Kaggle data set in R.
- **Finite element simulation of structures:**: Finite element simulation of a truss system to obtain the reactions and forces at different joints. Developed a finite element model of a plate structure with a hole and computed von mises stresses. Finite element modeling of beam and plate structures for static stresses, deflections, and natural frequencies.

Technical Presentations / Conferences / Invited Talks

- IDETC CIE 2023 in Boston, MA (upcoming)
- Presented the research titled *Modeling and Analysis of Multiple Electrostatic Actuators on the Response of Vibrotactile Haptic Device* at the ASME International Mechanical Engineering Congress and Exposition, Columbus, Ohio (Nov 2022)
- Presented the research titled *Modeling of large touch surfaces with electrostatic actuators for localized haptic feedback* at the Graduate Research Forum 2022, Miami University, Oxford, Ohio (Nov 2022)
- Delivered a virtual invited lecture on *Linear Control System Application Areas & Modeling of Mechanical Systems* for junior undergraduate students at NIT Silchar, India.
- Presented the research titled *Time delay estimation in a wireless control system and compensation with classical methods* at the Annual Symposium of the IEEE Power & Energy Society, NIT Silchar, India (Nov 2016)

Selected Courses

- **Graduate:** Advanced Mechanics of Materials, Finite Element Analysis, Control of Dynamic Systems, Applied Nonlinear Dynamics, Robotics: Design & Modeling, Intro to Artificial intelligence, Engineering Analysis, Advanced Data Visualization
- **Undergraduate:** Control System-I, Control System-II, Intelligent Control, Process Control, Industrial Instrumentation, Microprocessor & Micro-controller, Engineering Mechanics, Signals & Systems, Programming & Data Structures, Soft Computing.
- **MOOCs:** Machine Learning (Coursera), Deep Learning (Udemy), Complete Linear Algebra with MATLAB (Udemy), State of The Art Computational Methods & Software for Computer Aided Control Systems (Global Initiative of Academic Networks course at NIT Silchar)

HONORS & AWARDS

- Summer Research Fellowship from Miami University (2022,2023)
- Graduate Scholar Assistantship Award from Miami University (2021,2022)
- Best departmental undergraduate thesis award at NIT Silchar (2017)
- Best presenter award at the annual symposium of IEEE P&E society, NIT Silchar (2016)
- Undergraduate tuition scholarship from the government of Assam, India (2013-2017)
- Anundoram Borooah Award for excellence in high school leaving examination (2012)

LEADERSHIP, TEAMWORK, AND VOLUNTEERING EXPERIENCE

- Mentored a group of undergraduate students for the senior design project at Miami University.
- Publicity coordinator, International Graduate Student Association, Miami University (2021-22)
- Served as the president of the Indian Society for Technical Education, NIT Silchar chapter (2016-2017)
- Served as an organizing committee member for a workshop on Embedded Control Design at NIT Silchar (2016)
- Volunteered for Children of Hope, India to provide education to children from economically weaker and racial minorities background (2016-17)
- Organizing team member for Thundermarch: the annual rock festival and Indie Lake: the annual acoustic music festival at NIT Silchar. (2015-16)

References

- **Prof. Kumar Singh**, Professor, MME Department, Miami University, Oxford, Ohio (E-mail: singhkv@miamioh.edu)
- **Prof. Jeong-Hoi Koo**, Professor, MME Department, Miami University, Oxford, Ohio (E-mail: koo@miamioh.edu)
- **Dr. Rajeeb Dey**, Assistant Professor, NIT Silchar, India (E-mail: rajeeb@ee.nits.ac.in)