Basireddy Sandeep Reddy - Detailed Curriculum Vitae (Updated July 2023)

CONTACT INFORMATION

Phone (H): 0361-2584685
Phone (O): 0361-2582685
E-mail: bsandeepr@iitg.ac.in
(alt e-mail): bsandeepr07@gmail.com

Address for Correspondence:
D-304, Department of Mechanical
Engineering, IIT Guwahati,
Guwahati-780139, India

PROFESSIONAL EXPERIENCE

Dec 2018 - Date
- Assistant Professor, Mechanical Engineering, Indian Institute of Technology Guwahati, Guwahati-781039, India

July 2018 - Dec 2018
- Assistant Professor (Contract), Indian Institute of Information Technology Design and Manufacturing (IIITDM), Kurnool-518002, India

Aug 2016 to July 2018
- Postdoctoral Fellow, Center for Nano Science and Engineering (CENSE), Indian Institute of Science (IISc), Bangalore-560012, India

Aug 2015 to Aug 2016
- Research Associate at the Robotics and Design Lab, Mechanical Engineering, Indian Institute of Science (IISc), Bangalore-560012, India

DESCRIPTION OF RESEARCH

My primary research interests are in Nonlinear Dynamics, Robotics & Control.

Listed below are broad areas of my current research. The areas which I would like to explore in the future are also presented. These are areas in which I plan to work on in the near future. Also listed are the areas in which I have worked on in the past.

CURRENT RESEARCH
- Dynamics and Control of Underactuated Systems - One typical problem is the control of overhead cranes to damp out payload oscillations
- Dynamics and Control of Climbing Robots
- Underwater Robots
- Robotics for 3D printing

FUTURE RESEARCH
- Development of lower dimensional models for smooth motions of higher order robotic systems
- Mobile Robots (Kinematics, Dynamics, Control and Intelligence)
- Control of Robotic Systems using Fractional order Controllers

PAST RESEARCH
- Dynamics and Control of Rigid and Flexible Manipulators
- Nonlinear Dynamics of NEMS resonators
- Modeling and Control of robots actuated by Pneumatic Muscles

ACADEMIC PROFILE - EDUCATION

PHD	**Mechanical Engineering, Indian Institute of Science (IISc), Bangalore-560012, India**

- CGPA - 6.5 (8)
- Thesis - *A Study of Two Problems in Nonlinear Dynamics using the Method of Multiple Scales*
- Advisor: Prof. Ashitava Ghosal
- Thesis Submitted - 17 August 2015
- Thesis Defense - 04 March 2016
- Degree Awarded - 25 June 2016

M.TECH	**Mechanical Engineering, Indian Institute of Technology (IIT), Guwahati-781039, India**

- Specialization - Computer Assisted Manufacturing (CAM)
- CPI - 8.59 (10)
- Final Year Thesis - *Dynamics and Control of a Pneumatically Actuated Robot Arm*
- Advisor: Prof. S.K. Dwivedy
- Thesis Submitted (and Defense) - July 2009
- Degree Awarded - May 2010

B.E.	**Mechanical Engineering, K.J. Somaiya College of Engineering, Vidyavihar, University of Mumbai, Mumbai-400077, India**

- First Class with Distinction (71.1 Percent)
- Senior Year Thesis - *Analysis of Heat Pumps*, Advisor: Prof. Milind Rane, IIT Bombay.
- Degree Awarded - August 2007

HONORS AND AWARDS

- Invited reviewer for Mechanics Based Design of Structures and Machines - August 2018 onwards.
- Invited reviewer for the Asian MMS 2018 Conference, Bengaluru, India, Dec 2018.
- Invited reviewer for the Journal of Vibration and Control (SAGE Publishing) - July 2018 onwards
- Invited Speaker on IEEE-HKN Founders day, IISc Bangalore, India, October 2017.
- Post-Doctoral Fellowship, part of Nano mission, Department of Science and Technology (DST), India (2016-2017)
- Student Chairman of IEEE-IISc Student Branch, IISc Bangalore, India, 2011.
- Invited Speaker on Sixth Annual IEEE University Partnership Program (UPP) Leaders Summit: August 2011
- Doctoral Fellowship, IISc Bangalore, India (2009-2015)
- GATE postgraduate scholarship at IIT Guwahati, India (2007-2009)

PUBLICATIONS

JOURNAL PUBLICATIONS

Saurav Kumar Dutta, **B. Sandeep Reddy**, S.K. Dwivedy, *Complibot: A compliant external pipe climbing robot*, Mechanics Based Design of Structures and Machines, 2023. DOI: 10.1080/15397734.2023.2170884

Saurav Kumar Dutta, **B. Sandeep Reddy**, S.K. Dwivedy, *Tuning PID gains of a 3-D RRRP pick and place robot for asymptotic trajectory tracking*, ASME Journal of Dynamic Systems, Measurement and Control, 143(4), 041001, 2021.

B. Sandeep Reddy, A. Ghosal, *Robustness Analysis of a Simple and Augmented Proportional Plus Derivative Controller in Trajectory Following Robots Using the Floquet Theory*, ASME Journal of Computational and Nonlinear Dynamics - 13(7), 074501, 2018. doi: 10.1115/1.4040022

B. Sandeep Reddy, A. Ghosal, *Chaotic motion in a flexible rotating beam and synchronization*, *ASME Journal of Computational and Nonlinear Dynamics - - 12(4), 2017. doi: 10.1115/1.4035825

B. Sandeep Reddy, A. Ghosal, *Asymptotic stability and chaotic motions in trajectory following feedback controlled robots*, *ASME Journal of Computational and Nonlinear Dynamics*, 11(5), 2016. doi: 10.1115/1.4032389

B. Sandeep Reddy, A. Ghosal, *Nonlinear Dynamics of a Rotating Flexible Link*, *ASME Journal of Computational and Nonlinear Dynamics*, 10(6), 2015. doi: 10.1115/1.4028929

CONFERENCE
PAPERS

Shivani Raj, **B. Sandeep Reddy**, 3rd International Conference on Electrical, Computer, Communications and Mechatronics Engineering (ICECCME), Santa Cruz de Tenerife, Spain, July 20-21, 2023.

Arup Deka, **B. Sandeep Reddy**, *Emergency Braking Control in 3D Overhead Cranes using a switching PD-Fuzzy Controller*, 9 th International Conference on Control, Automation and Robotics (ICCAR 2023), April 21 23, 2023, Beijing, China.

Santosh Kumar, **B. Sandeep Reddy**, *Design of a novel tree-type robot for pipeline repair*, Robotics, Control, Automation and Artificial Intelligence (RCAAI-2022), 24-26 November 2022, Manipal Institute of Technology, MAHE, Manipal, India.

Shivani Raj, **B. Sandeep Reddy**, Arup Deka, *Emergency Braking Controller for the Overhead Cranes*, A Survey on Fault Tolerant Control of Unmanned Underwater Vehicles, NERC, IIT Guwahati, July 2022, Guwahati, India.

Arup Deka, **B. Sandeep Reddy**, *Emergency Braking Controller for the Overhead Cranes*, ME@75 Research Frontiers Conference (ACCEPTED), June 29-July 1, 2022, IISc Bengaluru, India.

Arup Deka, **B. Sandeep Reddy**, *A Fuzzy Controller for the Emergency Braking Problem in Overhead Cranes*, IEEE DELCON 2022, 11—13 February 2022, Netaji Subhas University of Technology, University in Delhi. DOI: $10.1109/DELCON54057.2022.9753630$

Sadha Sivam, Kallol Saha, **B. Sandeep Reddy**, *Algorithm for navigation of a mobile robot in energy-deficient environments*, IEEE DELCON 2022, 11—13 February 2022, Netaji Subhas University of Technology, University in Delhi. DOI: $10.1109/DELCON54057.2022.9753549$

Santosh Kumar, **B. Sandeep Reddy**, *Path-planning of robot end-effector for hairline crack sealing using Intelligent Techniques*, ICAMEMS 2022 (ACCEPTED), 22-24 January 2022, VIT-AP, Amravati AP, India.

Saurav Kumar Dutta, **B. Sandeep Reddy**, S.K. Dwivedy, A Kinematic Study of a RRRP Climbing Mechanism using Neuro-Fuzzy System, Asian MMS 2021, Dec. 15-18, 2021, Hanoi Vietnam.

Rohit Kumar, Rahul Meel, **B. Sandeep Reddy**, Integration of Path Optimization and Obstacle avoidance for Autonomous Precision Immobilization Technique Maneuver, 21st International Conference on Control, Automation and Systems (ICCAS), 12-15 October 2021, Jeju, Korea, Republic of, 753-758.

Saurav Kumar Dutta, **B. Sandeep Reddy**, S.K. Dwivedy, *Design of a Two Degrees of Freedom Actuator for Rehabilitation Robotic Applications*, (Accepted), 4th International and 19th National Conference on Machines and Mechanisms (iNaCoMM 2019), IIT Mandi, Dec 5-7, 2019.

B. Sandeep Reddy, S.K. Dwivedy, *Dynamics and Control of a Pneumatically Actuated Robotic*

Manipulator, 14'th National Conference on Machines and Mechanisms, NIT Durgapur, December 2009.

BOOK CHAPTERS   Shivani Raj, **B. Sandeep Reddy**, Arup Deka, *A Survey on Fault Tolerant Control of Unmanned Underwater Vehicles*, Chapter 11, Artificial Intelligence and Data Science Based R & amp;D interventions, Springer Nature, 2023.

PAPERS IN PROGRESS   Design and development of external pipe climbing robots : a critical survey. - with Saurav Kumar Dutta (Graduate Student, Mechanical Engineering, IIT Guwahati) and Prof. S.K. Dwivedy (Professor, Mechanical Engineering, IIT Guwahati)

Emergency Braking Control of drones carrying payloads - with Arup Deka (Graduate Student, Mechanical Engineering, IIT Guwahati)

Planning of pipe climbing robot for repair operations - with Santosh Kumar (Graduate Student, Mechanical Engineering, IIT Guwahati)

Collaborative robot path planning for additive manufacturing - with Kanak Jindal (Graduate Student, Mechanical Engineering, IIT Guwahati) and Prof. Sajan Kapil (Assistant Professor, Mechanical Engineering IIT Guwahati)

Review of amphibious vehicles - with Shivani Raj (Graduate Student, Mechanical Engineering, IIT Guwahati)

Sponsored Projects

IITG START-UP GRANT   Analysis, Control and Prototype Fabrication of a 3-axis Robot, Rs. 5 Lakh (Principal Investigator, Feb 2020 - Feb 2022)

TECHNOLOGY INNOVATION HUB, IITG TIDF   **Principal Investigator, 2020-2025** - Development of an Autonomous System for an Underwater Vehicle, Rs. 59.9 Lakh. Other Investigator: Prof. Nelson Muthu

TECHNOLOGY INNOVATION HUB, IITG TIDF   **Principal Investigator, 2020-2025** - Center for Advanced Training Program, Rs. 50 Lakh. Other Investigators: Prof. Sajan Kapil, Prof. S.K. Dwivedy, Prof. B. Panda.

NEWGEN IEDC   The Design and Fabrication of compliant pipe crawler to navigate pipe bends, Rs. 2 Lakh (Principal Investigator, Dec 2020 - Dec 2021)

NEWGEN IEDC   Development of Intelligent Vision System for Remotely Operated Vehicle (ROV) (Underwater), Rs. 2 Lakh (Dec 2021 - Dec 2022). Other Investigator: Prof. Nelson Muthu

NEWGEN IEDC   Fault Tolerant Control of Aerial Vehicles, Rs. 2 Lakh (Principal Investigator, Dec 2022 - Dec 2023).

Guidance of Students at IIT Guwahati

SAURAV K. DUTTA	• Design and Development of a Pipe Climbing Robot with a Compliant Bistable Gripping Mechanism (Jan 2019 - Dec 30 2021). Thesis Defended: 30 December 2021. Cosupervisor: Prof. S.K. Dwivedy, Professor, Mechanical Engineering, IIT Guwahati.
SANTOSH KUMAR	• Design and Control of Repair Robots (Jan 2019 - Till date)
ARUP DEKA	• Planning and Control of Drones carrying payloads (July 2019 - Till Date)
KANAK JINDAL	• Design of Hybrid Manipulator Kinematics based Machine Tools for Additive Manufacturing (Jan 2020 - Till Date). Cosupervisor: Dr. Sajan Kapil, Assistant Professor, Mechanical Engineering, IIT Guwahati.
SHIVANI RAJ	• Fault tolerant control of UAVs (Sep 2020 - Till Date)
ANKUR DEKA	• Design of lifting mechanisms for drones (May 2021 - Till Date)
SAHIL NARWAL	• Development of intelligent vision systems for ROVs (Jan 2021 - Till Date) Cosupervisor: Prof. Nelson Muthu, Assistant Professor, Mechanical Engineering, IIT Guwahati.
ANTARA SARKAR	• Autonomous tracking of underwater vehicles (Jan 2022 - Till Date) Cosupervisor: Prof. S.K. Dwivedy, Professor, Mechanical Engineering, IIT Guwahati.
M.TECH/MS STUDENT GUIDANCE	• 7 completed, 0 ongoing
B.TECH STUDENT GUIDANCE	• 8 BTech groups completed, 7 ongoing

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DETAILS OF COURSES TAKEN

IIT GUWAHATI	• Kinematics of Machinery - Jan-May 2021 and Jan-May 2022 (Ongoing) [B.Tech (4'th Semester)] • Kinematics Lab (Lab Course) - Jan-May 2021 and Jan-May 2022 (Ongoing) [B.Tech (4'th Semester)] • Theory of Machines Lab (Lab Course) - July-Nov 2021 [B.Tech (5'th Semester)] • Robot Design Laboratory (Lab Course) - July-Nov 2021 [M.Tech (1'st Semester)] • Introduction to Robotics (Minor Course in Robotics and Artificial Intelligence) - Sep 2020-Nov 2020, July 2021-Nov 2021 [B.Tech (3'rd semester)] • Machine Drawing (Lab Course) - July 2019 to Nov 2019 [B.Tech (3'rd Semester)] • Design of Machine Elements - July 2019 to Nov 2019 [B.Tech (5'th Semester)] • Engineering Mechanics - Jan 2019-May 2019, Jan 2020-May 2020 [B.Tech (2nd Semester)]
IIITDM KURNOOL	• Automation in Manufacturing - 31 July to Dec 2018 [B.Tech/ Dual Degree Program (5'th Sem)] • Manufacturing Automation Practice (Lab Course) - 31 July to Dec 2018 [B.Tech/ Dual Degree Program (5'th Sem)] • Concepts in Engineering Design - 31 July to Dec 2018 [B.Tech/ Dual Degree Program (1'st Sem)]

Education Programmes Organized

TEQIP-III	Robotics and 3D Printing (Organizer; Coorganizer is Dr Sajan Kapil, ME, IIT Guwahati), TEQIP-III (Five-day Workshop), Nov 30 – Dec 4, 2020.
COURSERA	Course Coordinator for Online Postgraduate Certificate Program in Robotics and Mechatronics (November 2022 onwards with three reruns in Feb 2023, May 2023 and August 2023) – IITG in partnership with Coursera. Program comprises six courses

- Kinematics of Machines – 5 weeks (Course Instructor along with Dr. Sajan Kapil, ME, IIT Guwahati)
- Dynamics of Machines – 3 weeks (taken by Prof. S.K. Dwivedy, ME, IIT Guwahati)
- Kinematics of Robots – 6 weeks (Course Instructor along with Dr. Sajan Kapil, ME, IIT Guwahati)
- Dynamics of Robots – 3 weeks (Course Instructor along with Prof. S.K. Dwivedy, ME, IIT Guwahati)
- Robot Sensing and Control – 6 weeks (Sole Course Instructor)
- Mechatronics – 5 weeks (Sole Course Instructor)

Invited Lectures

- Invited Speaker, *Novel grippers for pipe climbing robots*, Atal AICTE FDP on Mechatronics & MEMS, July 2021.
- Invited Speaker, *Control of Robots*, TEQIP-III Workshop on Robotics and Automation, March 2020.
- Invited Speaker on IEEE-HKN Founders day, IISc Bangalore, India, October 2017.

REVIEWER EXPERIENCE (JOURNALS)

Applied Mathematical Modeling, Elsevier

Nonlinear Dynamics, Springer

ISA Transactions, Elsevier

Journal of Computational and Nonlinear Dynamics (ASME Publications)

Journal of Vibration and Control (SAGE Publications)

Mechanics Based Design of Structures and Machines (Taylor & Francis Publishing)

Journal of Mechanisms and Robotics (ASME Publications)

Journal of The Institution of Engineers (India): Series C

Sadhana

International Journal of Advanced Robotic Systems, Sage Publications

ASME Journal of Dynamic Systems, Measurement and Control

ADMINISTRATIVE RESPONSIBILITIES AT IIT GUWAHATI

Associate Warden, Kameng Hostel, IIT Guwahati (July 2020 - Date)

Project Coordinator, Underwater ROV Group, IITG TI & DF, IIT Guwahati

CPPC Secretary, Center for Intelligent Cyber Physical Systems (CICPS), IIT Guwahati (March 2021 - Date)

Time-Table Coordinator, (Center for Intelligent Cyber Physical Systems) (March 2021 - Date)

Placement Coordinator, ME Department (December 2021 - Date)

Coordinator for ME Department Webpage (Decdember 2020 - Date)

Secretary, Faculty Meeting (December 2019 - October 2020)

Laboratory-in-Charge - Mechatronics and Robotics Lab, Theory of Machines Lab

Committee Member, M.Tech Selection (2019)

DETAILS OF PAST RESEARCH

August 2016 - July 2018

Nonlinear Dynamics of electrostatically actuated graphene based nanomechanical devices - Advisor: Prof. Akshay Naik (Carried out at CENSE, IISc Bangalore)

This research was part of a project awarded by the **Nano Mission, Department of Science and Technology (DST)** titled *Frequency stability of graphene based nanoelectromechanical devices.* The research dealt with analysis of the effects of geometric imperfections on the dynamical response of an electrostatically actuated clamped-clamped suspended graphene resonator, which were obtained by experiment and provided to me by CENSE, IISc Bangalore. The data showed hardening and softening frequency responses, but also in some cases showed a mixed softening-hardening response. My job was to validate this behavior and provide theoretical explanations for the same. As part of my research, I theoretically modeled the resonator as a beam using Reduced Order Modeling. I explained the role of higher order nonlinearities in the Reduced Order Model (ROM). I computed theoretically (using the Method of Multiple Scales) the amplitude of initial geometric imperfection (as a ratio of the thickness of the device) at which the mixed softening-hardening behavior began - in the process I was able to demonstrate that the onset of mixed behavior occured when the amplitude of imperfections was of the same order of magnitude as the thickness of the device. I considered two models of geometric imperfections - one as having the shape of the first bending mode, and secondly as a ripple. This work is valuable in understanding the role that nonlinearities play in 2D NEMS devices, which is useful in developing tunable bandpass filters and bifurcation based sensors. **This project was awarded till September 2017. However, given the cutting egde nature of the research, I continued to work at the NEMS Lab, CENSE, IISc till July 2018 to finish the research.**

August 2015 - August 2016

Asymptotic Stability of planar robots using the Floquet Theory - Advisor: Prof. Ashitava Ghosal (Carried out at Robotics and Design Lab, IISc Bangalore)

I expanded on the work done during my PhD on the issue of asymptotic stability of planar robots for trajectory tracking. The work done for PhD thesis dealt with showing, using the Method of Multiple Scales (MMS), that a planar two degree of freedom robot did not show asymptotic stability for trajectory tracking under feedback control. The application of MMS was only valid for small rotational values of the joint angles of the robot. In this work, we used the Floquet theory to study the asymptotic stability of planar robots, which is valid for all joint angles of the robot.

August 2009 - August 2015

PhD Thesis - A Study of Two Problems in Nonlinear Dynamics using the Method of

Multiple Scales. Advisor: Prof. Ashitava Ghosal (Carried out at Robotics and Design Lab, IISc Bangalore)

The thesis dealt with the study of two problems in the area of nonlinear dynamics using the method of multiple scales (MMS). The first problem dealt with the analytical criteria for a planar two degree of freedom (DOF) robot tracking a time dependent trajectory under feedback control. Certain papers in literature showed that simple proportional and derivative (PD) control and model based was sufficient to achieve asymptotic stability of planar two DOF robot for trajectory tracking provided the criteria, that the controller gains are positive, is satisfied. We showed using MMS, that for the PD controller, this criteria is necessary but not sufficient to conclude asymptotic stability. Furthermore, we showed that this criteria presumed that the actual parameters always matched the estimated model parameters of the robot. If the difference between the actual robot parameters and the estimated parameters was even slight, then asymptotic tracking cannot be achieved even for model based control.The second problem dealt with the nonlinear dynamics and chaos synchronization of a one link flexible beam. We the used the model of a power generating wind turbine blade as a description of the one link beam. Using MMS, we were able to show that for certain ranges of the physical parameters of the beam, the beam's motion showed chaotic behavior. To synchronize the chaos in the system, we developed a nonlinear controller using Lyapunov stability theory and demonstrated numerically that the error between the original and controlled system goes to zero.

Computer Skills
- Applications: LaTeX, MATLAB, MAPLE
- Operating Systems: Unix/Linux, Windows.

Personal Details
- Date of Birth   :   19/09/1986
- Nationality   :   Indian
- Language Proficiency :   English, Telugu, Hindi
- Marital Status   :   Married