Basireddy Sandeep Reddy - Detailed Curriculum Vitae (Updated Dec 2019)

Contact Information

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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 Climbing Robots
- Dynamics and Control of Underactuated Systems - One typical problem is the control of overhead cranes such that the payload does not oscillate unduly
- Design, Development and Control of Pneumatic Muscles
- Robotics for 3D printing
- Control of Robotic Systems using Fractional order Controllers

Future Research
- Development of lower dimensional models for smooth motions of higher order robotic systems - A typical problem in such an area is in trying to find 2 or 3 degree of freedom models for large motions of an n-link system
- Vibration-dominated impacts of interconnected systems - Involves studies of effects of impact at joints and bearings
- Investigations into nonlinear damping
- Mobile Robots (Kinematics, Dynamics, Control and Intelligence)

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

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

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.

PAPERS UNDER REVIEW

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.

B.Sandeep Reddy, Akshay Naik, *Qualitative Differences in Reduced Order Modeling of NEMS devices*, Nonlinear Dynamics.

Saurav Kumar Dutta, B.Sandeep Reddy, S.K. Dwivedy, *Dynamic analysis of a two degree of freedom Pneumatic Artificial Muscle (PAM) based actuator* - EURODYN 2020.

PAPERS IN PROGRESS

Design and Fabrication of a Gripping Mechanism with Application to a Pipe Climber - with Saurav Kumar Dutta (Graduate Student, Mechanical Engineering, IIT Guwahati) and Prof. S.K. Dwivedy (Professor, Mechanical Engineering, IIT Guwahati)

Effects of geometric imperfections on the dynamics of 2D NEMS devices - To be submitted with Prof. Akshay Naik, CENSE, IISc Bangalore

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Guidance of PhD Students at IIT Guwahati

SAURAV K. DUTTA
- Design, Development and Control of Pipe Climbers (Jan 2019 - Till date)

ARUP DEKA
- Dynamics and Control of Underactuated Systems (July 2019 - Till Date)

DETAILS OF COURSES TAKEN

IIT GUWAHATI
- 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 to May 2019 [B.Tech (2nd Semester)]

IIITDM KURNOOL
- Automation in Manufacturing - 31 July to Dec 2018 [B.Tech and Dual Degree Program (5'th Semester)]
- Manufacturing Automation Practice (Lab Course) - 31 July to Dec 2018 [B.Tech and Dual Degree Program (5'th Semester)]

- Concepts in Engineering Design - 31 July to Dec 2018 [B.Tech and Dual Degree Program (1'st Semester)]

Reviewer Experience (Journals)

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

Administrative Responsibilities at IIT Guwahati

Secretary, Faculty Meeting

Laboratory-in-Charge - 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.

August 2008 - August 2009

M.Tech Thesis - Dynamics and Control of a Pneumatically Actuated Robot Arm. Advisor: Prof. S.K Dwivedy, IIT Guwahati

The goal of this thesis was to design controllers for accurate motion control of a robot arm actuated by pneumatic artifical muscles. Because the highly nonlinear characteristics of the pneumatic muscles rendered the application of Classical Control Theory difficult, we used Fuzzy Control Theory to construct the controllers for accurate motion control. Although the scope of the work was limited to a robot arm with a maximum of two degrees of freedom, we provided recommendations for how the control problem ought to be approached for robots with higher degrees of freedom.

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