Chandrasekhar 'Nat' Nataraj

Department of Mechanical Engineering
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Research Interests

Rotor dynamics, vibration analysis, robot dynamics and control, nonlinear dynamics, vibration control, machinery prognostics, modeling of biological and interdisciplinary systems.

Education

12/87 Ph.D. in Engineering Science
Arizona State University (GPA=4.0/4.0)
Dissertation: "Periodic Oscillations in Nonlinear Mechanical Systems"
Advisor: Dr. Harold D. Nelson

5/84 M.S. in Mechanical Engineering
Arizona State University (GPA=4.0/4.0)
Thesis: "The Simulation of Cracked Shaft Dynamics"
Advisor: Dr. Harold D. Nelson

6/82 B.S. in Mechanical Engineering
Indian Institute of Technology, Madras, India (GPA=9.43/10.0)
Project: "Problems in Dynamics of Machinery"
Advisor: Dr. V. Ramamurti

Appointments

8/07 - present **Chair, Department of Mechanical Engineering**, Villanova University, Villanova, PA. Responsible for typical chair duties with a faculty of 22 full-time, 15 adjunct faculty, and four staff. The department has 330 undergraduate and 90 graduate students. In charge of arriving at and implementing strategic plans for the department and working with the other departments to implement the College and University vision. Responsible for keeping all the constituents (students, parents, faculty, staff, employers, higher adminstration, alumni) satisfied. Responsible for ABET accreditation (I have "lived" through three of these, and we are now preparing for the 2008 visit).

6/03 - present **Director, Center for Nonlinear Dynamics & Control (CENDAC)**, College of Engineering, Villanova University. This is an administrative posi-

tion reporting to the Dean of Engineering; Responsible for proposing, administering and sustaining a research program focusing on nonlinear dynamics and control. The current research expenditure is about $2 million and involves about ten faculty drawn from Mechanical, Electrical, Structural and Chemical Engineering departments.

6/04 - present **Professor of Mechanical Engineering**, Villanova University. I teach undergraduate and graduate courses in the areas of dynamics and control. I also advise graduate students on their theses and dissertations. I serve on various committees at departmental, college, university levels and in the general social and technical community.

8/95 - 6/04 Associate Professor of Mechanical Engineering, Villanova University.

9/88 - 94 Assistant Professor, Mechanical Engineering, Villanova University

1/88 - 5/88 Adjunct Assistant Professor, Mechanical Engineering, Villanova University
Instruction of a graduate course on system dynamics and control.

11/87 - 9/88 Research Engineer & Vice President, Trumpler Associates, Inc., West Chester, Pennsylvania
Independent research and consulting in rotor dynamics and vibrations.

8/85 - 5/87 Instructor, Arizona State University
Instruction of Statics, Dynamics, and Strength of Materials.

8/84 - 5/85 Laboratory Instructor for Advanced Mechanics of Materials Laboratory

8/82 - 6/84 Graduate Research Assistant, Arizona State University
Research in rotor dynamics.

Research Contracts and Grants

- C. Nataraj, November 2006 - April 2007, "Research in Support of Oceangoing Decontamination System - Phase 1," Ablaze Development Corporation, November 1, 2006, $46,354.
- C. Nataraj, May 2007 - August 2008, "Research in Support of Oceangoing Decontamination System - Phase 2," Ablaze Development Corporation, $290,000.
- C. Nataraj, June 2007-May 2008, "Autonomous Systems Research," Office of Naval Research, $1,200,000.
- C. Nataraj, April 2007-June 2008, "High Fidelity Modeling of Electromagnetic Bearings With PM Bias," Office of Naval Research, $82,271.
- C. Nataraj, December 2007-November 2008, "Impact analysis of water lubricated bearings - Phase 1," Curtis Wright EMD, $42,500.

- C. Nataraj, “Sting free grip analysis on golf clubs,” Sting Free, May 2007-September 2007.
- C. Nataraj, “Smart communication system - Phase 2”, Turbo Research Foundation, January 2007 - December 2007, $7,000.
- C. Nataraj, “Smart communication system - Phase 1”, Turbo Research Foundation, July 2006 - April 2007, $5,000.
- C. Nataraj, July 2006 - October 2006, “Vibration analysis of reciprocating saws,” Sting Free/Bosch.
- C. Nataraj, “Student research scholarships, National Institute of Standards and Technology, June 2006-September 2006, $7,000.
- C. Nataraj, May 2006 - December 2006, ”Verification of hand and FEA analytical methods for welded Al sections,“ (PI: Gross), Pagnotta Engineering/BFTP, $15,000.
- C. Nataraj, August 2005 - January 2006, ”Development of software protocols in automation equipment,“ Fairmount Automation/BFTP, (PI: Kulkarni) $11,000.
- C. Nataraj, June 2005 - December 2005, ”Characterizing next generation seal materials,“ Stein Seals/BFTP, (PI: Santhanam) $11,000.
- C. Nataraj, June 2005 - December 2005, ”Investigation of robotic transport system,“ (PI: Ashrafiuon) Ablaze/BFTP $11,000.
- C. Nataraj, ”Student research scholarships, National Institute of Standards and Technology, June 2005-September 2005, $5,400.
- C. Nataraj and R. Hoffman, June 2004 - June 2005, “All wheel drive motorcycle testing and analysis,” Christini Techologies/BFTP, $21,500.
- C. Nataraj, May 2004 - May 2005, “Biped robots with moving torso,” Turbo Research Foundation, $4,000.
- C. Nataraj, “Student research scholarships, National Institute of Standards and Technology, June 2004-September 2004, $8,400.
- C. Nataraj, ”Development of a personal water craft,“ (PI: Kroos) H2O Sports/BFTP, August 2003 - November 2003, $31,000.
- C. Nataraj, December 2005-November 2006, ”Nano-structured composites for enhancing fabrication productivity,“ Advanced Ceramics Research; $600K.
- C. Nataraj & Ahmad Hoorfar, September 2005-December 2006, ”Autonomous Systems Research for Future Naval Technologies,“ Office of Naval Research; $900K.
- C. Nataraj, June 2004-May 2005, “Intelligent Navigation of Unmanned Surface Vehicles With Obstacle Avoidance,” Office of Naval Research; $60K.
- C. Nataraj, June 2004-September 2005, “Automated Diagnostics & Prognosis of Screw Compressors,” Aerzen USA; $21K.

- C. Nataraj, Jun 2001-August 2001, "Modeling and Control of Ship Fluid Systems," Naval Surface Warfare Center, Carderock Division, Philadelphia (Monitor: Mr. Don D'Alessandro); \$16K.
- C. Nataraj, August 1999-May 2001, "Dynamics & Control of Mobile Manipulators," DARPA, MDA972-97-1-0020; \$232K.
- C. Nataraj, August 2000-May 2001, "Development of Educational Video for Vibration & Control," Villanova Institute for Teaching & Learning; \$4K.
- C. Nataraj, May 1999-July 1999, "Review of Bearingless Motors," Naval Surface Warfare Center, Carderock Division, Philadelphia (Monitor: Mr. Thomas E. Calvert); \$15K.
- C. Nataraj, June 1998-August 1998, "Dynamic Response of Rotating Machinery on Magnetic Bearings," Naval Surface Warfare Center, Carderock Division, Annapolis (Monitor: Mr. Thomas E. Calvert); \$20K.
- C. Nataraj, May 1997-July 1997, "Design of Magnetic Bearings for Propulsion Shafts: A Feasibility Study," Naval Surface Warfare Center, Carderock Division, Annapolis (Monitor: Mr. Thomas E. Calvert); \$24K.
- C. Nataraj, July 1995–October 1995, "Signal Analysis for Failure Prediction in Rotating Machinery," Ben–Franklin Industry-University Cooperative Research Grant (with Conrad Technologies, Inc., Great Valley, PA).
- C. Nataraj, and Adam Trotter, October 1993–September 1995, "Theory of Active Control Algorithms for Vibration Reduction in Rotating Machinery," Naval Surface Warfare Center, Carderock Division; \$30K.
- C. Nataraj, June 1994–August 1994, "Nonlinear Analysis of Magnetic Bearings," Office of Research and Sponsored Projects, Villanova University.
- C. Nataraj, June 1989–August 1989, "An Active Control Algorithm for Reducing Residual Vibration in Rotating Machinery," Office of Research and Sponsored Projects, Villanova University.
- H. D. Nelson, M. Rajan, and C. Nataraj, January 1987–December 1987, "Periodic Motion of Mechanical Systems With Nonlinear Components," NASA Lewis Research Center Grant NAG3-580.

Professional Activities

- Organizer of Symposium on Nonlinear Analysis, Control and Diagnostics of Rotor Systems, part of ASME Design Technology Conference, September 2007.
- Organizer of Symposium on Dynamic & Vibration of Robotic Systems, part of ASME Design Technology Conference, September 2001, September 2003.

- Organizer of Symposium on Dynamic & Vibration of Geared Systems, part of ASME Design Technology Conference, September 1999.
- Reviewer for many journals including *ASME Journal of Vibrations, Acoustics, Stress and Reliability in Design*, *ASME Journal of Applied Mechanics*, *STLE Tribology Transactions*, *Journal of Sound and Vibration*, *International Journal of Rotating Machinery* and *Journal of Mechanisms*.
- Reviewer for many Ph.D. dissertations from Indian Institute of Science, Bangalore, and Indian Institute of Technology, Madras.
- Elected member, American Academy of Mechanics
- Member, American Society of Mechanical Engineers
- Member, IEEE.
- Reviewer for ASME Vibrations Conferences since 1987.
- Member, American Society of Engineering Education
- Member, Sigma Xi, the Scientific Research Society

Supervision of Postdocs & Visiting Faculty

- Dr. Biswanath Samanta, Prognostics in machinery and biological systems, 2007-present.
- Dr. Yan-fei Jin, Nonlinear dynamics in ship motions, 2007-present.
- Dr. S. P. Harsha, Nonlinear dynamics in ships; nonlinear dynamics of bearing defects. 1/2006-5/2007; currently a faculty at Indian Institute of Technology, Rourkee.
- Dr. Farbod Fahimi, Postdoctoral associate from January 2000 - August 2002, Dynamics & Control of Mobile Robots; Hyper-redundant manipulators; currently a faculty at University of Alberta.
- Dr. Ashitava Ghosal, Associate Professor, Indian Institute of Science, June 2000-August 2000, Dynamics of Mobile Robots in three-dimensional terrain.
- Dr. Biswanath Samanta, Associate Professor, Sultan Qaboos University, Muscat, Oman, May 2006-August 2006, Prognostic algorithms for machinery.
- Dr. Getachew Hailu, Cisco Corporation, January 2002-May 2002, AI techniques for mobile robot navigation.

Graduate Theses & Dissertation Advisement

- Frank Ferrese, "Algorithms for Intelligent Autonomy of UAV/USV/UUVs," Ph.D. dissertation, started Fall 2006.
- Karthik Kappaganthu, "Combined model-based and data-driven prognostic algorithms for machinery," Ph.D. dissertation, started Summer 2007.
- Kristin Dormuth, "Nonlinear dynamics and modeling of walking robots," Ph.D. dissertation, started Summer 2007.
- Premkumar Pisupati, "Modeling of vibration in nano-tubes and similar structures," M.S. thesis, expected September 2007.
- Mayank Jain, "LTV control coupled with obstacle avoidance for unmanned surface vehicles," M.S. thesis, expected September 2007.
- Karthik Kappaganthu, "A novel self-controlled biped robot," M. S. thesis; February 2007.
- Robert Pietrusko, "Factorial Hidden Markov Models for Condition-Based Monitoring," M.S. thesis, December 2006.
- Pritesh Khasliwal, December 2005, "Intelligent Navigation of Unmanned Surface Vehicles," M. S., Villanova University.
- Rineesh Siddhareddy, April 2007, "Navigation of groups of unmanned surface vehicles," M. S., Villanova University.
- Anil John, December 200, "Analysis and Design of a Pneumatic Haptic Device," M. S., Villanova University.
- Steven Marx, September 2005, "Controller Design of Magnetic Bearings for Rotors with Moving Supports," M. S., Villanova University.
- Deepak Harathi, December 2003, "Dynamics & Control of Nonlinear Models of Magnetic Bearings," M.S., Villanova University.
- Kiarash Emami, December 2004 (expected), "Dynamics & Control of Cooperative Mobile Robots," M.S., Villanova University.
- Masoud Feghhi, September 2002, "Optimum Path Planning for Mobile Robots With Non-holonomic Constraints" M.S., Villanova University.
- Adam Trotter, 1999, "Experimental Observation of Nonlinear Phenomena in Active Magnetic Bearings," M.S., Villanova University.
- Farshid Asl, 1998, "Analysis of Hyper-redundant manipulators," M.S., Villanova University.
- Srinivas Mallapragada, 1996, "An Active Control Algorithm for Vibration Reduction in Rotating Machinery," M.S., Villanova University.

- Arunkumar Sampath, 1994, "Optimal Design of Coupled Structures Subjected to Random Excitation," M.S., Villanova University.
- Rajesh Rao, 1994, "Error Analysis of a Single Link Flexible Robot," M.S., Villanova University.
- Ramesh Kadambi, 1993, "Control of a Flexible Robot Driven By Spur Gears," M.S., Villanova University.
- Erik vaughn Vogel, "Effectiveness of Controller Algorithms for Use With Magnetic Bearings," M.S., (on-going), Villanova University.

Scholarships and Awards

5/01 - 7/01	U.S. Navy-ASEE Summer Fellowship
5/99 - 7/99	U.S. Navy-ASEE Summer Fellowship
6/98 - 8/98	U.S. Navy-ASEE Summer Fellowship
1/88	National Research Council Postdoctoral Associateship (did not accept)
7/85	Associated Students of ASU Special Graduate Scholarship (awarded to one distinguished student in the College of Engineering)
1/84 - 5/87	Regents Graduate Academic Scholarship, ASU
8/82 - 5/87	Graduate Assistantship, Mechanical and Aerospace Engineering, ASU
8/82 - 5/83	Special Industrial Fellowship, ASU
7/77	Indian National Science Talent Scholarship
8/77 - 6/82	Government of India Merit Scholarship

Journal Publications & Peer-reviewed Conference Publications

1. S. P. Harsha and C. Nataraj 2007, "Nonlinear Dynamic Analysis Of A Rotor Bearing System Due To Distributed Defects Using Factorial Design Of Experiments, *International Journal of Applied Mechanics and Engineering*, Vol.12, No. 2, pp. 379-399.
2. Sergey G. Nersesov, C. Nataraj, and Jevon Avis, 2007, "Design of Finite-Time Stabilizing Controllers for Nonlinear Dynamical Systems," 46th IEEE Conference on Decision and Control, New Orleans, LA, December 12-14.
3. C. Nataraj and Steven Marx, 2007, "Bifurcation analysis of a one DOF rotor on magnetic bearings," ASME IDETC conference, September 4-7, Las Vegas, NV.
4. S. P. Harsha and C. Nataraj, 2007, "The Effect of Surface Waviness and Number of Rolling Elements on the Dynamic Behavior of Rotor-Bearing Systems," ASME IDETC conference, September 4-7, Las Vegas, NV.
5. B. Samanta and C. Nataraj, 2007, "Cracked Rotor Diagnostics Using Soft Computing," Paper No. DETC2007-35181, ASME IDETC conference, September 4-7, Las Vegas, NV.

6. S. P. Harsha and C. Nataraj, 2007, "Dynamic Analysis of High-Speed Ball Bearings Due to Geometrical Imperfections," Arctic Summer Conference on Dynamics, Vibrations and Control, Saariselkä, Finland, August 6-10.

7. C. Nataraj and S. P. Harsha, 2007, "Intermittent Chaos in Steering Dynamics of Ships," Arctic Summer Conference on Dynamics, Vibrations and Control, Saariselkä, Finland, August 6-10.

8. B. Samanta and C. Nataraj, 2007, "Machinery Prognostics Using Soft Computing," The 17th International Conference on Flexible Automation and Intelligent Manufacturing, June 18-20, Philadelphia, PA.

9. B. Samanta and C. Nataraj, 2007, "Automated Diagnosis of Cardiac State in Healthcare Systems," The 17th International Conference on Flexible Automation and Intelligent Manufacturing, June 18-20, Philadelphia, PA.

10. S. P. Harsha and C. Nataraj, 2006, "Nonlinear Vibration Analysis of a High Speed Unbalanced Rotor Supported by Rolling Element Bearings Due to Race Waviness," being reviewed for publication in *Nonlinear Dynamics*.

11. S. P. Harsha and C. Nataraj, 2006, "Nonlinear Vibration Analysis of a Rotor Bearing System Due to Surface Imperfection of Rolling Elements," being reviewed for publication in *Mechanics Based Design of Structure and Machines*.

12. S. P. Harsha and C. Nataraj, 2006, "Nonlinear Vibration Response of a Balanced Rotor Supported on Rolling Element Bearings," being reviewed for publication in *Nonlinear Dynamics*.

13. S. P. Harsha and C. Nataraj, 2006, "Nonlinear Dynamic Analysis of a Rotor Bearing System Due to the Effect of Surface Waviness," being reviewed for publication in *Communications in Nonlinear Science and Numerical Simulation*.

14. S. P. Harsha and C. Nataraj, 2006, "Chaotic, Sub-harmonic and Periodic Analysis of a Balanced Rotor Supported by Roller Bearings," being reviewed for publication in *Institution of Mechanical Engineers, Part C, Journal of Mechanical Engineering Science*.

15. B. Samanta and C. Nataraj, 2006, "Detection and diagnostics of cracked rotors using soft computing," Proc. 10th Mechatronics Forum Biennial International Conference - Mechatronics 2006 (MX2006), Penn State Great Valley, Malvern, June 19-21.

16. Steven Marx and C. Nataraj, 2006, "Suppression of Base Excitation Of Rotors on Magnetic Bearings," *International Journal of Rotating Machinery*.

17. C. Nataraj and S. P. Harsha, 2006, "The Effect of Bearing Cage Run-out on Nonlinear Dynamics of Rotating Shaft," *Communications in Nonlinear Science and Numerical Simulation*.

18. S. P. Harsha P. K. Kankar and C. Nataraj, 2006, "The Effect of Ball Waviness on Nonlinear Vibrations Associated with Rolling Element Bearings," accepted for publication in *International Journal of Acoustics and Vibration*.

19. S. P. Harsha and C. Nataraj, 2006, "Nonlinear Dynamic Analysis of an Unbalanced Rotor Supported by High-Speed Rolling Element Bearings with Effect of Surface Waviness." *International Journal of Nonlinear Sciences and Numerical Simulation*, Vol. 7, No. 2, pp. 5-9.

20. C. Nataraj and Kenneth Muske, 2006, "Nonlinear Dynamics in Chemical Processes," Invited paper, Encyclopedia of Chemical Processing, Marcel Dekker, Inc.

21. C. Nataraj and Steven Marx, 2005, "An Optimal Control Algorithm for Suppression of Harmonic Base Excitation in Nonlinear Magnetic Bearings," ASME International Design Engineering Technical Conferences, Long Beach, CA, September 24-28.

22. C. Nataraj and Robert Pietrusko, 2005, "The Effect of a Growing Outer Race Defect on the Dynamic Response of a Rigid Rotor," ASME International Design Engineering Technical Conferences, Long Beach, CA, September 24-28.

23. C. Nataraj and Pritesh Kasliwal, 2005, "Nonlinear Dynamic Response of Unmanned Surface Vehicles Compared For Various Ship Models," Intelligent Ships Symposium VI, Villanova, PA.

24. David A. Cartes, C. Nataraj, and John Metzer, 2005, "Path Planning and Nonlinear Model Selective Control Using Neural Networks: Precision Maneuvering of Unmanned Surface Vehicles," Intelligent Ships Symposium VI, Villanova, PA.

25. Steven Marx and C. Nataraj, 2005, "A Combined PD and Optimal Control of a Nonlinear Magnetic Bearing Rotor Subject to Harmonic Base Motion," Intelligent Ships Symposium VI, Villanova, PA.

26. C. Nataraj and Pritesh Kasliwal, 2005, "Linear Time Varying Control of Unmanned Surface Vehicles," Intelligent Ships Symposium VI, Villanova, PA.

27. Farbod Fahimi, Rineesh SiddaReddy, and C. Nataraj, 2005, "Formation Control of Unmanned Surface Vehicles," Intelligent Ships Symposium VI, Villanova, PA.

28. Steven Marx and C. Nataraj, 2004, "A Control Technique used to Compensate for Magnetic Bearing Responses to Base Motion," ASNE EMTS 2004 Symposium January 27-29, 2004, Philadelphia, PA.

29. C. Nataraj and Thomas E. Calvert, 2003, "Compensation of base motion in magnetic-bearing supported rotors for Navy applications," Intelligent Ships Symposium V, May 2003.

30. C. Nataraj and Bryan Wenzel, 2003, "Effect of Dynamics on Path Planning of Mobile Robots," Proceedings of DETC2003, 19th Biennial ASME Conferences on Mechanical Vibration and Noise, Paper No. DETC2003/VIB-48509, Sept. 2-5, Chicago, IL.

31. Fahimi, F., Ashrafiuon, H., and Nataraj, C., 2003, "Obstacle Avoidance for Spatial Hyper-Redundant Manipulators Using Harmonic Potential Functions and the Mode Shape Technique." Journal of Robotic Systems, Vol. 20, No. 1, pp. 23-33.

32. Fahimi, F., Ashrafiuon, H., and Nataraj, C., 2002, "An Improved Inverse Kinematic and Velocity Solution for Spatial Hyper-redundant Robots," IEEE Transactions on Robotics and Automation, Vol. 18, No. 1, pp. 103-107.

33. F. Asl, H. Ashrafiuon & C. Nataraj, 2002, "A General Solution for the Position, Velocity, and Acceleration of Hyperredundant Planar Manipulators," *Journal of Robotic Systems,* Vol. 19, No. 1, pp. 1–12.

34. Fahimi, F., Ashrafiuon, H., and Nataraj, C., "Inverse Kinematic Solution for Universal-Jointed Hyper-Redundant Robots," Proceedings of the ASME DETC/CIE 2002 Conference, Paper No. DETC2002/ MECH-34228, Sept. 29- Oct. 2, 2002, Montreal, Canada.

35. Fahimi, F., Ashrafiuon, H., and Nataraj, C., "Obstacle Avoidance for 2D Hyper-Redundant Manipulators Using Harmonic Potential Functions and the Mode Shape Technique," Proceedings of DETC2001, 18th Biennial ASME Conferences on Mechanical Vibration and Noise, Paper No. DETC2001/VIB-21527, Sept. 9-12, 2001, Pittsburgh, PA.

36. C. Nataraj and N. K. Arakere, 1999, "Dynamic response and stability of a spur gear pair," 17th ASME Biennial Conference on Mechanical Vibration and Noise, September.

37. N. K. Arakere and C. Nataraj, 1999, "Numerical simulation of nonlinear spur gear dynamics," 17th ASME Biennial Conference on Mechanical Vibration and Noise, September.

38. F. Asl, H. Ashrafiuon, and C. Nataraj, 1999, "Analysis of Hyper-redundant manipulators," 17th ASME Biennial Conference on Mechanical Vibration and Noise, September.

39. C. Nataraj and T. E. Calvert, 1998, "Optimal Design of Radial Magnetic Bearings," in *Proceedings of the Sixth International Symposium on Magnetic Bearings*, pp. 296–305.

40. C. Nataraj and A. M. Whitman, 1997, "Parameter Excitation Effects in Gear Dynamics," presented at the 16th ASME Biennial Conference on Vibration and Noise, Sacramento, CA.

41. G. F. Jones and C. Nataraj, 1997, "Heat Transfer in an Electromagnetic Bearing," *Journal of Heat Transfer*, Vol. 119, pp. 611–616.

42. N. K. Arakere and C. Nataraj, 1997, "In–Plane Vibration of High–Speed Spur Gear Webs," *Trans. ASME,* [1] *Journal of Vibration and Acoustics*, Vol. 120, No. 3, pp. 791–800.

43. C. Nataraj, 1995, "Nonlinear Analysis of a Rigid Rotor on a Magnetic Bearing," presented at the International Gas Turbine Institute (ASME) conference, Houston.

44. A. M. Sampath, C. Nataraj, and H. Ashrafiuon, 1995, "Optimal Design of Coupled Structures Subjected to Random Excitation," presented at the 15th ASME Biennial Conference on Vibration and Noise, Boston.

45. C. Nataraj, N. K. Arakere, and H. Ashrafiuon, 1994, "Effect of Fluid Inertia on Journal Bearing Parameters," *Tribology Transactions*, Vol. 37, No. 4, pp. 784–792.

[1] American Society of Mechanical Engineers

46. C. Nataraj and H. Ashrafiuon, 1993, "Optimal Design of Centered Squeeze Film Dampers," *Trans. ASME, Journal of Vibration and Acoustics*, Vol. 115, pp. 210–215.

47. C. Nataraj, 1993, "On the Nonlinear Interaction of Torsion and Flexure in Rotating Shafts," *Trans. ASME, Journal of Applied Mechanics*, Vol. 60, pp. 239-241.

48. C. Nataraj, 1993, "Flexibility Effects in a Single Link Robotic Manipulator," *Vibrations and Dynamics of Robotic and Multibody Structures*, ASME DE-Vol. 57.

49. H. Ashrafiuon and C. Nataraj, 1992, "Dynamic Analysis of Engine Mount Systems," *Trans. ASME, Journal of Vibration and Acoustics*, Vol. 114, No. 1, pp. 79-83.

50. C. Nataraj and H. D. Nelson, 1989, "Periodic Oscillations in Rotor Dynamic Systems With Nonlinear Supports: A General Approach," *Trans. ASME, Journal of Vibration, Acoustics, Stress and Reliability in Design*, Vol. 111, pp. 187-193.

51. C. Nataraj and H. D. Nelson, 1989, "The Application of Trigonometric Collocation Method to the Determination of Periodic Solutions in Nonlinear Systems," *Proceedings of the 1989 ASME Conference on Vibration and Noise*, Montreal.

52. H. D. Nelson and C. Nataraj, 1986, "The Dynamics of a Rotor System With a Cracked Shaft," *Trans. ASME, Journal of Vibration, Acoustics, Stress, and Reliability in Design*, Vol. 108, No. 2, pp. 189-196.

53. C. Nataraj, H. D. Nelson, and N. Arakere, 1985, "An Analytical Study of a Rigid Rotor System With a Coulomb Spline," *Instability in Rotating Machinery*, NASA CP-2409, pp. 225-233.

54. M. Kamath, R. Narasimhan, C. Nataraj, and V. Ramamurti, 1982, "Dynamic Response of Multicylinder Engines With a Hysteretic Crankshaft Damper," *Journal of Sound and Vibration*, Vol. 81, No. 3, pp. 448-452.

Papers Under Review

- F. Ehrich and C. Nataraj, 2007, "Nonlinear Vibrations," invited paper for inclusion in *Shock and Vibration Handbook¿*

- B. Samanta and C. Nataraj, 2007, "Machinery Prognostics Using Soft Computing," being reviewed for publication in *Robotics and Computer Integrated Manufacturing*.

- B. Samanta and C. Nataraj, 2007, "Automated Diagnosis of Cardiac State in Healthcare Systems," being reviewed for publication in *International Journal for Services Operations and Informatics*.

- C. Nataraj, Karthik Kappaganthu and H. D. Nelson, 2007, "Nonlinear response of a rotor system with a spline coupling," under review for publication in *ASME Journal of Nonlinear Dynamics*.

- Karthik Kappaganthu and C. Nataraj, 2007, "A biped with a moving torso," being reviewed for publication in *Journal of Humanoid Robotics*.
- Farbod Fahimi, C. Nataraj and Hashem Ashrafiuon, 2003, "Real time obstacle avoidance for groups of mobile robots," under review for publication in *Journal of Robotic Systems*.

Other Conference Proceedings

- S. P. Harsha and C. Nataraj, 2006, "Nonlinear Vibration Analysis Of A Balanced Rotor Supported By Roller Bearings," AIAA-ASME Mini Symposium, Philadelphia, PA.
- G. Hailu, C. Nataraj and H. Ashrafiuon, 2001, "Is Reduction in Task Space a Condition for Accelerated Learning?" accepted for presentation at the IEEE Systems, Man & Cybernetics Conference, October, Tucson, AZ.
- C. Nataraj, N. K. Arakere, and H. Ashrafiuon, 1992, "Effect of Fluid Inertia on Journal Bearing Parameters," presented at the *STLE* [2] *Annual Tribology Meeting*, Philadelphia.
- C. Nataraj and P. K. Raju, 1992, "The Vibrational Response of Coupled Composite Beams," *Proceedings of the Second International Congress on Recent Developments in Air and Structure Borne Sound and Vibration*, Auburn, Alabama.
- H. Ashrafiuon and C. Nataraj, 1991, "Dynamic Analysis of Serial Rotary Manipulators With Flexible Links," *Proceedings of the Second National Applied Mechanisms and Robotics Conference*, Cincinnati, Paper No. 91 AMR-IIB-2.
- H. Ashrafiuon and C. Nataraj, 1990, "Effect of Flexibility on Manipulator Dynamics," *Proceedings of the Fifth International Conference on CAD/CAM, Robotics, and Factories of the Future,* Paper No. 90-101, Norfolk, VA.
- C. Nataraj and C. E. Wallace, 1990, "The Application of Statistical Energy Analysis to the Study of Energy Flow in Beam Networks," *Proceedings of the International Congress on Recent Developments in Air and Structure Borne Sound and Vibration*, Auburn, Alabama.

Patents

- Textured Rolling Element Bearing, patent application submitted December 2002. With Thomas Falone, Carmen DiMario and Robert Vito.
- "Embodied Music System," patent application submitted September 2007. With Robert Pietrusko.

[2]Society of Tribologists and Lubrication Engineers

Technical Reports

- C. Nataraj, Matthew V. Frank and Kevin C. King, 2005, "Dynamic Response to a Shock Impulse Of a Centrifugal Compressor Rotor Supported By Magnetic Bearings," NSWCCD-98-TR-2005/22, October, NAVSEA Philadelphia, PA.
- Masoud Feghhi and C. Nataraj, 2002, "Obstacle Avoidance and General Path Planning of Car-like Robots," Report to CTC, May 22, 2002.
- C. Nataraj, August 2001, "Modeling and Control of Ship Fluid Systems," Report to Naval Surface Warfare Center, Carderock Division, Philadelphia.
- Getachew Hailu, C. Nataraj and Hashem Ashrafiuon, 2001, "The Relative Influence of Biasing and Search Space Size on Learning Behavior," Report to CTC, October 12, 2001.
- C. Nataraj and Bryan Wenzel, 2001, "Dynamic Analysis and Control of Wheeled Mobile Devices," Report to CTC, October 1, 2001.
- Hashem Ashrafiuon, John Majerus, C. Nataraj, T. Radhakrishnan, Sridhar Santhanam, 2000, "Miniature Mobile Robot Actuators," Report to CTC, February 14, 2000.
- Ashitava Ghosal and C. Nataraj, 2000, "Modeling of wheeled mobile robots on uneven terrain," Report to CTC, August 24, 2000.
- Hashem Ashrafiuon, Frank DiMeo, Mark Jupina, Steven Konyk, Jr., John Majerus, Bijan Mobasseri, C. Nataraj, T. Radhakrishnan, Sridar Santhanam, Pritpal Singh, and Anthony Zygmont, (Collated and Edited by Joseph Di Giacomo), 1999, "Gap Analysis, System Engineering for Miniature Devices, ID Technical State-of-the-art and Expertise in, Microelectronics, MEMS, Nanotechnology, Sensors, Power, Wireless Communications, Algorithms, Robotics, Mechanical Devices," Report to CTC, November 8, 1999.
- C. Nataraj and Bryan Wenzel, 1999, "Gap Analysis Report On Mobile Devices," Report to CTC, November 16, 1999.
- C. Nataraj, 1998, *Dynamic Response of Rotating Machinery on Magnetic Bearings: Status Report*, Report to Naval Surface Warfare Center, Carderock Division, Annapolis, MD.
- C. Nataraj, 1997, *Design of Magnetic Bearings for Propulsion Driveshafts: A Feasibility Study*, Report to Naval Surface Warfare Center, Carderock Division, Annapolis, MD.
- C. Nataraj, 1996, *Performance of Cream Dispenser*, Report to Belavadi Enterprises, Inc., Eagleville, PA.
- C. Nataraj, 1995, *Signal Analysis for Failure Prediction in Rotating Machinery*, Report to Conrad Technologies, Inc., Great Valley, PA.
- C. Nataraj, 1995, *Dynamic Analysis of the Hercules Roller Coaster Ride*, Report to Stagliano and Associates, Media, PA.

- C. Nataraj, 1994, *A Finite Element Model of Rotating Machinery Supported on Magnetic Bearings*, Report to Integrated Engineering, United Kingdom.
- C. Nataraj, 1993, *Rotor on a Magnetic Bearing: 1 DOF Model*, Report to Integrated Engineering, United Kingdom.
- H. D. Nelson, C. Nataraj and W. J. Chen, 1989, *Periodic Motion of Mechanical Systems With Nonlinear Components*, NASA Report NAG 3-580.
- C. Nataraj, 1989, *An Active Control Algorithm for Vibration Reduction in Rotating Machinery*, Report to Villanova University Office of Research and Sponsored Projects.
- C. Nataraj, 1987, *Periodic Oscillations in Nonlinear Mechanical Systems*, Ph.D. Dissertation, Arizona State University (Advisor: Dr. Harold D. Nelson).
- C. Nataraj, 1984, *The Simulation of Cracked Shaft Dynamics*, M.S. Thesis, Arizona State University (Advisor: Dr. Harold D. Nelson).
- C. Nataraj (with M. Kamath and R. Narasimhan), 1982, *Problems in the Dynamics of Machinery*, B.Tech Project Report, Indian Institute of Technology, Madras (Advisor: Dr. V. Ramamurti).

Recent Invited Seminars

- Johns Hopkins University, October 2007.
- Stevens Institute of Technology, March 2007.
- Birla Institute of Technology, May 2007.
- Indian Institute of Technology, Rourkee, May 2007.
- Indian Institute of Technology, Chennai, May 2007.
- Indian Institute of Science, Bangalore, August 2006.
- Lockheed Martin Space Systems, Moorestown, NJ, October 2006.
- Naval Surface Warfare Center, October 16, 2003.
- Fraunhofer Institut, Berlin, Germany, June 25, 2003.
- Concurrent Technologies Corporation, Johnstown, PA, June 2, 2003.
- Ford Motor Company, Powertrain division, Detroit, MI, May 19, 2003.
- Indian Institute of Science, Bangalore, December 2002.

Service

Technical Societies

- Elected member, ASME Technical Committee on Vibration & Sound (TCVS), 2002-present. This committee organizes the largest Vibration conference in the world, and oversees ASME's Journal of Vibration and Acoustics.
- Member of the Bower Medal Preselection Comittee, Franklin Institute, 2007. This committee was responsible for preselecting the recipients for the prestigious Bower medal ($250K) awarded by the Franklin Institute for lifetime contribution in robotics. Franklin Institute medals are among the oldest and most prestigious in the world and have been awarded for 182 years.
- Chairman, Public Affairs Committee, ASME Philadelphia Section, 1994.

University Committees

- University Research Grants Review Committee, 1999-present.
- Engineering Dean Search Committee, 2004-2005.
- Multicultural Affairs Committee
- Focus group for the University Mission Effectiveness Committee, 2000.

College Committees

- Ph.D. Mathematics Examination Committee, 2004-present
- Ph.D. Policies Committee, 2001-2003.
- College of Engineering Leadership Council, 2002-2005.
- College of Engineering Research Council, 2002-2005.
- Academic Integrity Committee, 1998-2000.
- Engineering IT Committee, 1998-2005.

Department Committees

- ABET Committee, 2001 (last ABET visit to Villanova)
- Graduate Committee, 1998-present

- Curriculum Committee, 1988-1997.
- Chair, Controls Search Committee, 2003-2005.
- 3-year faculty evaluation committee, 2004, 2005.
- Department Chair Evaluation Committee, 1994.
- Laboratory Committee, various years.
- Undergraduate Admissions Committee, 1989-1994.
- Webmaster, 1999-2002
- Thesis committees of many students (about two per year) since 1988.

Other Professional Boards

- Chairman of the Board of Directors, Turbo Research Foundation, 1998-present (on the Board since 1987). TRF is a non-profit organization located in West Chester, PA, that sponsors scholarly research in engineering sciences. We have an endowment the proceeds of which will be used to fund annual scholarships and awards. I organize annual meetings with the Board and set future direction.
- Scientific Adviser, StingFree Technologies Corporation, Kennett Square, PA (2002-present).

Community Service

- Judge, Homeschool Science Fairs, 2003-present.
- Served on the Organizing Committee for the First North American Kannada Literary Conference, May 2004. Co-sponsored by Department of Modern Languages.
- Member of the Board of Council of Indian Organizations, Philadelphia, 2002-present.
- Sruti, The India Music and Dance Society. This is a volunteer non-profit organization with about 2000 members that focuses on organizing concerts in Indian classical music and dance that are typically performed by major artists from India (like Ravi Shankar, for example).
  - Served as an elected member of the Board of Directors, 2001-2002. Served as Treasurer and was responsible for all financial and accounting aspects of the organization. Wrote proposals (and received grants) from various funding organizations.
  - Editor, *Sruti Notes*, 2004.
  - President-Elect, 2007.
  - President, 2008.

- Served as the Vice President and as an elected member of the Board of Directors for Triveni, Kannada Association of Delaware Valley, 2003-2004. This is a volunteer non-profit organization with about 300 families that focuses on fostering the music, arts and culture of Karnataka, a south Indian cultural population.
- Executive committee of Associations of Indians in America (Philadelphia), 1993-1996.

Student Mentoring

- Advisor, Villanova Unmanned Boat, Summer 2007-present. With a student group of five undergraduates, three graduate students, and a Navy advisor, we designed, built and competed in the AUVSI's (Association of Unmanned Vehicle Systems International) USV demonstration in Orlando, Florida (August 2007). "Best Design" Prize.
- Faculty Advisor, American Society of Naval Engineers, Student Association, 2005-present.
- Advisor, Bathtub racer, 1990. Designed and built a bathtub racer, and competed in the annual competition. Won first place in rookee race.
- Faculty Advisor, Indian Student Association, 1989-1995.
- Faculty Advisor, Engineering Graduate Student Council, 1990's.

Courses taught

Undergraduate

- E.C.E. 210 Statics (sophomore)
- E.C.E 311 Dynamics (sophomore)
- E.C.E. 314 Strength of Materials (sophomore)
- M.E. 422 Advanced Mechanics of Materials Laboratory (senior)
- MAT 2500 Calculus III (sophomore)
- M.E. 4102 System Dynamics (senior)
- M.E. 5202 Vibrations (junior)
- M.E. 5203 Introduction to Automatic Control (senior)
- M.E. 5204 Dynamics of Flight (senior)
- M.E. 5421 Robotics (senior)
- M.E. 4801 Mechanical Engineering Senior Design Seminar (senior)

- M.E. 2901 Mechanical Engineering Laboratory I (sophomore)
- M.E. 3902 Mechanical Engineering Laboratory II (junior)
- M.E. 3903 Mechanical Engineering Laboratory III (junior)
- M.E. 4901 Mechanical Engineering Laboratory IV (senior)

Graduate

- M.E. 7000 Advanced Engineering Analysis (applied mathematics)
- M.E. 7206 Dynamics of Rotating Machinery
- M.E. 8203 System Dynamics and Automatic Control
- M.E. 8207 Vibration Analysis
- EGR 8306 Nonlinear Dynamics

Personal Data

- Citizen of U.S.A.
- Fluent in English, German, Kannada, Hindi, and Tamil.