CURRICULUM VITA

of

Dr. ATUL G. KELKAR

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Contents

Personal:

Born: Alibag, India, 1963. **U.S. Citizen**.

Education:

Ph.D. Mech. Engg., Old Dominion University, Norfolk, VA, USA, August 1993
> *Ph.D. Dissertation Title*: *Robust Control of Nonlinear Multibody Flexible Space-Structures*

M.S. Mech. Engg., Old Dominion University, Norfolk, VA, USA, April 1990
> *M.S. Thesis Title*: *The Effect of Payload Dynamics on Trajectory Tracking Performance of a Robot Manipulator*

B.S. Mech. Engg., University of Poona, Pune, India, June 1984

Employment History:

Iowa State University, Ames, Iowa. *Professor (Aug. 05- present), Associate Professor (Jan.01 - Jul. 05). Mechanical Engineering Engineering.*

Kansas State University, Manhattan, Kansas. *Associate Professor (Aug.99-Dec.00), Assistant Professor (Jan. 96-Aug.99). Mechanical and Nuclear Engineering.*

VSI Aerospace, Inc., Ames, IA. *Co-Founder and Chairman of Board, (2007-present).*

Vibroacoustics Solutions, Inc., Ames, IA. *Co-Founder and Chairman of Board, (2004-present).*

Innovative Energy Solutions, Inc., Ames, IA. *Co-Founder and Chairman of Board, (2007-present).*

Innovative Vibrations Solutions, Inc., Ames, IA. *Co-Founder and Chairman of Board, (2006-present).*

NASA Langley Research Center, Hampton, Virginia. *Associate Fellow, National Research Council (NRC)*, 1994- 1996.

Old Dominion University, Norfolk, Virginia. *Visiting Assistant Professor*, Aerospace Engineering Dept., Aug. 1993 - Aug. 1994
Adjunct Assistant Professor, Mechanical Engineering Dept., Aug. 1993 - Jan. 1996.

NASA Langley Research Center, Hampton, Virginia. *Research Associate*,1990 -1993.

Old Dominion University, Norfolk, Virginia. *Graduate Research Assistant*, Jan. 1988 - May. 1990. *Teaching Assistant*, Aug. 1987 - Jan. 1988.

Larsen and Toubro Limited, Bombay, India. *Design and Planning Engineer*,1984-1987.

Tata Engineering and Locomotive Co. Ltd., Pune, India. *Trainee Engineer*, Jun. 1982 - Dec. 1982 and Jan. 1984 - Jun. 1984.

Honors and Awards:

- Fellow, ASME; Associate Fellow, AIAA
- Keynote Speaker, TURING100 - International Conference On Computing Sciences (ICCS), 2012.
- Recipient of **NSF CAREER** award.
- Honored Member of America's Registry of Outstanding Professionals
- Founder of four technology companies.
- Listed in Marquis Who's Who in America.
- Author of the research monograph: "*Control of Nonlinear Multibody Flexible Space Structures*"- Springer-Verlag, London, 1996.
- Invited author for contributions in: "*Electrical Engineering Handbook*", Academic Press, 2003.
- Invited guest speaker on *Tech Talk with Craig Peterson*, a public radio station (focused on technology talks) for work on NASA's Jupiter Icy Moons Orbiter project. Interview was aired to four different radio stations around Boston area.
- Interviewed by KCCI News Channel 8, Des Moines Register, Business Record, Ames Tribune, and Iowa State Daily for work on NASA's Hypersonic Research Project.
- First Place winner in 2011 Papajohn Business Competition.
- Second Place winner in 2009 Papajohn Business Competition.
- Third Place winner in 2008 Papajohn Business Competition.
- Interviewed by Iowa Public Radio for research accomplishments in Active Noise Control, aired in 2001.
- Featured in an article "*The Sound of Silence*", in industry magazine, *Rock Products*, June 2001, pp. 11-14, under a special column entitled Ideas and Trends by Chief Editor of the magazine.
- Invited author for contributions in: "*The Control Handbook*", CRC Press and IEEE Press, 1995.
- Invited author for contributions in: "*Control System Applications*," CRC Press, 2000.
- Recipient of ***National Research Council (NRC) Fellowship***, 1994-1996.
- Nominated for ASME Dynamic Systems and Control Division's *Outstanding Young Investigator Award*, 1999 (one of the five nominees).
- Nominated for *Engineering Research Excellence Award*, Kansas State University, 2000.
- Best Paper in the Session Award, 2007 International Conference on Advances in Control and Optimization of Dynamical Systems, IISc, Bangalore, India, February 1-2, 2007.
- Best Paper in the Session Award, 2003 American Control Conf., Denver, CO, June 4-6, 2003.
- Best Paper in the Session Award, 1998 American Control Conf., Philadelphia, PA, June 1998.
- Best Paper in the Session Award, 1993 American Control Conf., San Francisco, CA, June 1993.
- Ranked **FIRST** in the University at B.S. examination, 1984.
- Recipient of National Merit Scholarship by Govt. of India, 1978.

Research Highlights:

- **Excellence in research:** Dr. Kelkar has built a highly successful and internationally known research program which has a complementary blend of fundamental and applied research. His numerous scholarly activities include: large number of archival papers (over 100) published in leading ASME, AIAA, and IEEE journals and proceedings, sustained competitive extramural funding, publication of a high-level research monograph, book chapters (3), numerous invited seminars, leadership in technical committees, organizational activities, editorial appointments for leading journals, technology transfer through entrepreneurial activities, and placement of graduate students in highly respected organizations.

- **Funding:** Dr. Kelkar has maintained a healthy research program with uninterrupted funding (averaging over \$600K/year with total over \$7MM) from several NASA centers, NSF, State of Iowa, DoD, and industries like Deere, Boeing, Sauer-Danfoss, Caterpillar, etc.

- **Honors and Awards:** Dr. Kelkar's selected few honors include, Fellow ASME, Associate Fellow, AIAA, Senier Member IEEE, NSF Career Awardee, Selection for NASA Creativity & Innovation Program Award, NRC Fellowship, Associate Editorship of leading ASME and IEEE journals, Member of NASA's Supersonic and Hypersonic GNC Research Teams, Guest Speaker on science and technology radio show, Founder of four technology companies, and several leadership position in ASME and AIAA.

- **Research leadership:** Dr. Kelkar is a recognized leader in AIAA's Aerospace Systems community, ASME's Dynamic Systems and Control community, and IEEE's Control System Society. Served as Aerospace Technical Panel Chair for ASME for several years. Associate Editor for both IEEE and ASME's leading controls journals. He has made significant contributions in the area of modeling and control of nonlinear multibody aerospace and mechanical systems, active control of noise and vibration, and integrated robust design. His research has given rise to new methodologies for modeling, simulating, and controlling complex dynamic systems. His work on multibody modeling and control has led to a unique software tool namely Integrated Robust Optimal Design (IROD), the beta version of which was recently released to John Deere who sponsored the research for over 6 years. He has been a member of the elite research group for several prestigious NASA projects including International Space Station, Supersonic Transport, Jupiter Icy Moons Orbiter (JIMO), and most recently Hypersonic Project. Member of NASA's Hypersonic Guidance Navigation and Control team in developing control-relevant modeling and analysis tools for design of future hypersonic vehicles.

- **Breadth of research:** Dr. Kelkar's accomplishments also demonstrate significant breadth and innovation in research leading to new emerging research directions. Since 2007 Dr. Kelkar is engaged in Renewable Energy area and has already made significant impact in real world applications. In collaboration with industrial partner he has developed a technology to convert waste hydrocarbons such as waste plastics, used tires, and refinery residue in liquid fuel such as diesel. He also launched a technology start-up to commercialize this technology. The company has already attracted refinery servicing industries for sizable investment and commercial scale

plant orders. He has built a pilot plant in State Of Iowa's Biomass Energy Conversion facility in Nevada, Iowa. He is working on developing this technology further for more efficient and robust operation. His breadth of the research program is evident from interdisciplinary research work through several collaborations on- and off-campus. Collaborations include joint projects with faculty from Chemistry, Physics, Ag and Biosystems, Aerospace, and Electrical Engineering and with several faculty and NASA researchers off-campus.

- **Technology transfer and its impact**: Dr. Kelkar's foundational research in noise and vibration control has resulted in several patentable technologies and several NSF and NASA sponsored projects. Dr. Kelkar's research has led to five U.S. Patent applications and two disclosures. Two patents have been granted and two are published. Two patents are on the active pneumatic suspension system, two are on active control of acoustic noise, and one is on Depolymerization of Waste Hydrocarbons to Liquid Fuels. The potential applications of these patents have led to the formation of successful start-up companies in ISU Research Park which have succeeded not only in acquiring prestigious NSF and NASA projects but also won business competition awards at state level competitions.

- **Extension activity**: Dr, Kelkar has also offered engineering assistance to many small and big Iowa companies through several CIRAS and IPRT research projects. Some recently finished successful projects involved ISU start-up VSI, MidAmerican utility company, SwitchQuick, Link Mfg., Caterpillar, Sears Manufacturing, and Maytag.

    Dr. Kelkar has helped several Iowa-based industries in the area of dynamic modeling and analysis, vibration and noise analysis, frequency response analysis, and mechanical design. Some noteworthy projects include noise control of operator cabins in ag and construction machines, dynamic analysis of rotary washers and dryers, noise mitigation in washer and dryers, noise mitigation in dental drills, development of smart materials for noise and vibration mitigation, and vibration isolation in truck cabs.

- **Visibility to University**: Dr. Kelkar's research and entrepreneurial success has led to several interviews on national and local public radio stations, local TV stations, news papers, and several magazines and reports. These press and news coverage has brought lot of visibility to department, college, and ISU.

Patents:

1. USPTO Patent # 8,302,944. H. Porumamilla, A. Kelkar, J. Vogel, *Pneumatic Vibration Isolation Device*, Issued November 6, 2012.

2. USPTO Patent # 12/819,137: *Thermo-Catalytic Cracking For Conversion of Higher Hydrocarbons into Lower Hydrocarbons* by A. G. Kelkar and P. V. Bhat, Filed June 18, 2010, Published December, 2010.

3. USPTO Patent Application #: 20090010447- U.S. Class: 381 716 (USPTO), Int. Class. G10K 11/16, A61F 11/06, *Active noise control system*, by T. Waite and A. G. Kelkar, Published Jan. 8 2009.

4. USPTO Patent # 7,623,993 issued on November 24, 2009 - A. G. Kelkar and S. M. Joshi: *Method and System to Perform Energy extraction-based Active Noise Control.*

5. U.S. Patent Application # 11/187, 366 - Jerry Vogel and A. G. Kelkar: *A Continuously Variable Natural Frequency Vibration Isolation System*, Filed July 2005.

6. U.S. Patent Application # 60/647,489 - Christopher Whitmer, Craig Shores, Atul Kelkar: *Active-Passive Composite Material for Vibration and Noise Control*, Filed January 2005.

Publications:

Books

[1] A. G. Kelkar and S. M. Joshi. *Control of Nonlinear Multibody Flexible Space Structures*, volume 221 of *Lecture Notes in Control and Information Sciences*. Springer-Verlag, August 1996.

Book Chapters

[1] O. Gonzalez and A. G. Kelkar. *Robust Multivariable Control*, chapter in Electrical Engineering Handbook. Academic Press, 2004.

[2] S.M.Joshi and A. G. Kelkar. *Control of Flexible Space Structures*. CRC Press, 2000. Chapter 7.3 in Control Systems Applications.

[3] S. M. Joshi and A. G. Kelkar. *Control of Flexible Space Structures*, chapter 75.3, pages 1316–1326. CRC Controls Handbook, CRC and IEEE Press - Times Mirror Books, first edition, 1995.

Book Reviews

[1] A. G. Kelkar *Book Review: 'Digital Control Engineering'* by M. Sami Fadali, *Brooks/Cole Publishing.* March 2001.

[2] A. G. Kelkar and H. R. Pota *Book Review: 'Signal Processing for Active Control*, by Stephen Elliott, Academic Press, in *International Journal of Noise Control Engineering*, Vol. 50, No. 3, May-June 2003.

[3] A. G. Kelkar *Book Review: 'Systems Dynamics'*, by William Palm, McGraw-Hill Higher Education, to be published in 2003. A. G. Kelkar *Book Review: 'Modeling and Simulation for Automatic Control'* by Olav Egeland and J. T. Gravdahl, *Marine Cybernetics*, Trondheim, Norway. 2002.

[4] A. G. Kelkar *Book Review: 'Dynamic Modeling and Control of Engineering Systems'* by Shearer,Kulakowski, and Gardner. *Prentice Hall.* 2004.

Journal Publications and Peer-Reviewed NASA Papers

[1] A. G. Kelkar and S. M. Joshi. Robust control of nonlinear flexible multibody systems using quaternion feedback and dissipative compensation. *NASA Technical Memorandum*, (TM-109099), April 1994.

[2] A. G. Kelkar. Mathematical modeling of a class of multibody flexible space structures. *NASA Technical Memorandum*, (TM-109166), December 1994.

[3] S. M. Joshi and A. G. Kelkar. Three-axis stabilization of spacecraft using parameter-independent nonlinear quaternion feedback. *NASA Technical Memorandum*, (TM-109150), September 1994.

[4] A. G. Kelkar, S. M. Joshi, and T. E. Alberts. Dissipative controllers for nonlinear multibody flexible space systems. *Journal of Guidance, Control, and Dynamics*, 18(5):1044–1052, 1995.

[5] A. G. Kelkar, S. M. Joshi, and T. E. Alberts. Passivity-based controllers for flexible multibody systems. *IEEE Transactions on Automatic Control*, 40(5):910–914, May 1995.

[6] S. M. Joshi, A. G. Kelkar, and P. G. Maghami. A class of stabilizing controllers for flexible multibody systems. *NASA Technical Paper -3494*, May 1995.

[7] S. M. Joshi, A. G. Kelkar, and J.-T. Wen. Robust attitude stabilization of spacecraft using nonlinear quaternion feedback. *IEEE Transaction on Automatic Control*, 40(10):1800–1803, October 1995.

[8] S. M. Joshi, P. G. Maghami, and A. G. Kelkar. Design of dynamics dissipative compensators for multibody flexible space structures. *IEEE Transactions on Aerospace and Electronic Systems*, 31(4):1314–1324, October 1995.

[9] A. G. Kelkar, S. M. Joshi, and T. E. Alberts. Dynamic dissipative compensators for multibody flexible space structures. *IEEE Transactions on Aerospace and Electronic Systems*, 31(4):1325–1330, October 1995.

[10] A. G. Kelkar and S. M. Joshi. Global stabilization of flexible multibody spacecraft using quaternion-based nonlinear control law. *Journal of Guidance, Control, and Dynamics*, 19(5):1186–1188, 1996.

[11] S. M. Joshi and A. G. Kelkar. On longitudinal control of high speed aircraft in the presence of aeroelastic modes. *NASA Technical Memorandum*, (TM-110254), 1996.

[12] S. M. Joshi and A. G. Kelkar. Robust control of a class of passive nonlinear systems. Technical Report TM 110287, NASA Technical Memorandum, October 1996.

[13] A. G. Kelkar. On the dynamics and control of flexible multi-body nonlinear space systems. *IMechE*, (C553/027):343–352, 1998.

[14] S. M. Joshi and A. G. Kelkar. Inner loop control of supersonic aircraft in the presence of aeroelastic modes. *IEEE Transactions on Control System Technology*, 6(6):730–739, November 1998.

[15] A. Isidori, S. M. Joshi, and A. G. Kelkar. Asymptotic stability of interconnected passive non-linear systems. *International Journal of Robust and Nonlinear Control*, 9:261–273, 1999.

[16] A. G. Kelkar and S. M. Joshi. Passivity-based robust control with application to benchmark active controls technology wing. *AIAA Journal of Guidnace, Control, and Dynamics*, 23(5):938–947, 2000.

[17] A. G. Kelkar, Y. Mao, and S. M.Joshi. Synthesis of lq-optimal constant-gain positive-real controllers. *Control and Intelligent Systems*, 29(3):65–73, 2001.

[18] H. R. Pota and A. G. Kelkar. On perfect acoustic noise cancelling control. *IASTED Journal of Intelligent Systems and Control*, 28, No.2, pp. 48-54(2):48–54, 2001.

[19] H. R. Pota and A. G. Kelkar. Modelling and control of acoustic ducts. *ASME Journal of Vibration and Acoustic*, 123(1):2–10, January 2001.

[20] S. M. Joshi and A. G. Kelkar. Passivity-based robust control of systems with redundant sensors and actuators. *International Journal of Control*, 74(5):474–481, March 2001.

[21] S. Woodard, A. G. Kelkar, and G. Koganti. Multidisciplinary concurrent design optimization via the internet. *NASA Technical Memorandum*, (TM-2001-210644), March 2001.

[22] F. Andreev, D. Auckley, S. V. Gosavi, L. Kapitanski, A. G. Kelkar, and W. N. White. Matching, linear systems, and the ball and beam. *Automatica*, 38(12):2147–2152, 2002.

[23] S. M. Joshi and A. G. Kelkar. Design of norm bounded and sector-bounded lqg controllers for uncertain systems. *International Journal of Optimization Theory and Applications*, 113(2):269–282, May 2002.

[24] S. M. Joshi, D. E. Cox, and A. G. Kelkar. Robust control of uncertain systems via norm- and sector-bounded lqg-type controllers. *International Journal of Optimization Theory and Applications*, 113(2):269–282, May 2002.

[25] H. R. Pota, I. R. Petersen, and A. G. Kelkar:. Robust control of a 2-d acoustic enclosure. *ASME Journal of Vibration and Acoustics*, 125:1–10, 2003.

[26] P. Krishnaswami and A. G. Kelkar. Optimal design of controlled multibody dynamic systems for performance, robustness, and tolerancing. *Engineering with Computers*, 19:26–34, 2003.

[27] A. G. Kelkar and H. R. Pota. Robust broadband control of acoustic noise in ducts: a passvity-based approach. *International Journal of Noise Control Engineering*, 51(2):97–105, March-April 2003.

[28] S.V.Gosavi and A. G. Kelkar. Modelling, identification, and passivity-based robust control of piezo-actuated flexible beam. *ASME Journal of Vibration and Acoustics*, 126(2):260–271, April 2004.

[29] B. Fang, A. G. Kelkar, S. M. Joshi, and H. R. Pota. Modeling and control of acoustic noise in 3-d enclosures with acoustic-structure interaction. *Control Engineering Practice, Elsevier Publication*, 12(Special Issue On Emerging Technologies for Active Noise and Vibration Control Systems):989–1004, 2004.

[30] D. Soloway, J. Shi, and A. G. Kelkar. Gpc-based stable reconfigurable control. *NASA Technical Paper*, (2008-215358), 2008.

[31] R. C. Fales, E. Spencer, and A. G. kelkar. Robust control design for a construction machine using lqg and h-infinity based methods. *ASME Journal of Dyanamic Systems, Measurement, and Control*, 2008. (under revision).

[32] A. G. Kelkar and S. M. Joshi. Control of elastic systems via passivity-based methods. *Journal of Vibration and Control*, 10:1699–1735, 2004.

[33] R. C. Fales, E. Spencer, K. Chipperfield, F. Wagner, and A. G. Kelkar. Modeling and control of a wheel loader with a human-in-the-loop assessment using virtual reality. *ASME Journal of Dynamic Systems Measurement and Control*, 127:415–423, 2005.

[34] F. Liu, B. Fang, and A. G. Kelkar. Energy extraction-based robust lqg control of acoustic-structure interaction in 3-d enclosure. *ASME Journal of Vibration and Acostics*, (VIB-03-1054), 2007.

[35] J. Shi, A. G. Kelkar, and D. Soloway. Stable reconfigurable generalized predictive control of with application to flight control. *ASME Journal of Dynamic Systems Measurement and Control*, 128(371-378), 2006.

[36] C. Whitmer, P. Vu, A. G. Kelkar, and F. Chavez. Modeling and control of morphing wing structure. *AIAA Journal of Aircraft*, 2010. (in review).

[37] J. Carrigan, A. G. Kelkar, and P. Krishnaswami. Integrated design of controlled mechanisms for performance, robustness, sensitivity, and manufacturability. *Journal of Optimization*, 2010. (in review).

[38] H. Porumamilla and A. G. Kelkar. Robust control of active automobile suspension. *SAE Transactions Journal of Passenger Cars: Mechanical Systems*, 2010. (in review).

[39] C. Whitmer and A. G. Kelkar. Aeroelastic modeling and lqg-based robust control of morphing wing. *Journal of Aircraft*, 2010. (in review).

[40] A. G. Kelkar, Y. Mao, and S. M.Joshi. Lmi-based passification for control of nonpassive systems. *Automatica*, 2010. (in review).

[41] V.Kapila, A.G.Kelkar, and Y. Mao. Passification via dynamic feedback compensation. *European Journal of Control*, 2010. (in review).

[42] N. Manjarekar, R. N. Banavar, and A. G. Kelkar. Robust passification using norm bounded uncertainty models. *IEEE Transactions on Control System Technology*, 2:1327 – 1332, 23-25 June 2003.

[43] D. Robinson and A. G. Kelkar. H-infinity design for hydraulic front wheel drive speed control of a motor grader. *IEEE Transactions on Control System Technology*, 2010. (in review).

[44] C. Whitmer and A. G. Kelkar. Robust control of morphing wing structure. *Journal of Aircraft*, 2010. (in review).

[45] K. Kruck and A. G. Kelkar. Active control of vibrations in tall structures subjected to earthquake and wind disturbances. *Journal of Vibration and Control*, 2010. (in review).

[46] Marco B. Quadrelli, Jerry Langmaier, Edward Mettler, Konstantin Gromov, Emmanuell Murray (JPL), Don Soloway, Bill Walz Atul Kelkar (ARC), Bill Lightsey, Brent Beabout, and Kevin Betts (MSFC). Aacs tb2.5 trades study report. Technical Report JIMO Document 3457-04-012, Prepared For Jupiter Icy Moons Orbiter Project, Jet Propulsion Laboratory, California Institute of Technology, Pasedena, CA, September 2004.

[47] H. Porumamilla, A. G. Kelkar, and J. M. Vogel. Modeling and verification of an innovative active pneumatic vibration isolation system. *ASME Journal of Dynamic Systems, Measurement, and Control*, 130(3):1–12, 2008.

[48] Jay Shi and Atul Kelkar. Comparison of different controllers for nonlinear model of jupiter icy moons orbiter,. *ASME Journal of Dynamic Systems, Measurement, and Control*, 2010. (submitted).

[49] Jay Shi and Atul Kelkar. Feedback linearization based generalized predictive control of jupiter icy moons orbiter. *ASME Journal of Dynamic Systems, Measurement, and Control*, 131:011003–0110013, 2009. (One of the Ten Most Downloaded articles from the journal in January 2009).

[50] Jay Shi and Atul Kelkar. A dissipative control design for jupiter icy moons orbiter. *Journal of Dynamic Systems Measurement and Control*, 129(4):559–565, 2007.

[51] T. Waite, Q. Zou, and A. G. Kelkar. Inversion-based feedforward approach to broadband acoustic noise reduction. *ASME Journal of Vibration and Acoustics*, 130(051010):1–7, 2008.

[52] Roger Fales and Atul Kelkar. Robust control design for a wheel loader using h-infinity and feedback linearization based methods. *ISA Transactions,Published by Elsevier Ltd.*, February 2009.

[53] Manoj Karkee, Brian Steward, Atul Kelkar, and Zachery Kemp. Modeling and real-time simulation architectures for virtual prototyping of off-road vehicles. *Springer-Verlag Journal - SI: Manufacturing and Construction*, (DOI 10.1007/s10055-009-0150-1), December 2009.

[54] Punit Tulpule and Atul Kelkar. Integrated robust optimal design using bmi approach via sensitivity minimization. *ASME Journal of Dynamic Systems, Measurement, and Control*, 2013 (submitted). (in review).

[55] Adam Shuttleworth and Atul Kelkar. Toward a multi-objective, multi-level optimization based engineering decision tool. *Optimization and Engineering, Springer*, 2013 (submitted). (in review).

[56] W. D. Robinson, A. G. Kelkar, and J. M. Vogel. Semi-active control methodology for suspension vibration control of an air spring-valve-accumulator system. *Journal of Vibration and Control*, 2013 (submitted). (in review).

Published Proceedings

[1] A. G. Kelkar and T. E. Alberts. Computing maximum tracking error due to payload dynamics. In *Proceedings of the IEEE International Conference on Robotics and Automation*, volume 2, pages 851–855, Cincinnati, Ohio, May 13-18 1990.

[2] A. G. Kelkar and T. E. Alberts. Optimal control/structure integrated design of a flexible space platform with articulated appendages. In *Proceedings of the SPIE Conference*, Orlando, Fl, 1991.

[3] T. E. Alberts, A. G. Kelkar, and B. Siciliano. Two-time scale control for an arm with joint and link compliance. In *Proceedings of the International Symposium on Intelligent Robotics*, pages 138–146, Bangalore, India, January 3-5 1991.

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[6] A. G. Kelkar, S. M. Joshi, and T. E. Alberts. Globally stabilizing controllers for flexible multibody systems. In *Proceedings of the IEEE Conference on Decision and Control*, volume 3, pages 2856–2859, Westin La Paloma, Tucson, Arizona,, December 16-18 1992.

[7] A. G. Kelkar, S. M. Joshi, and T. E. Alberts. Global asymptotic stability of dynamic dissipative compensators for multibody, flexible space structures. In *Proceedings of the 1993 American Control Conference*, volume 2, pages 1277–1281, Westin St. Francis, San Francisco, California, June 2-4 1993.

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[9] S. M. Joshi and A. G. Kelkar. Inner loop control of supersonic aircraft in the presence of aeroelastic modes. In *Proceedings of the IEEE Conference on Control Applications*, Dearborn, Michigan, September 15-18 1996.

[10] W. N. White, A. G. Kelkar, and R. Fales. A hydraulically actuated compound pendulum. In *Proceedings of the IEEE Conference on Control Applications*, Dearborn, Michigan, September 15-18 1996.

[11] A. G. Kelkar and S. M. Joshi. Trajectory tracking of multibody spacecraft. In *Proceedings of the 1996 International Mechanical Engineering Congress and Exposition*, Atlanta, GA, November 17-22 1996.

[12] A. G. Kelkar and S. M. Joshi. Globally stable maneuvers of flexible space robots. In *Proceedings of the Fourth International Conference on Control, Automation, Robotics, and Vision*, volume 1, pages 167–171, Westin Stamford, Singapore, December 3-6 1996.

[13] A. G. Kelkar and S. M. Joshi. Robust control of non-passive systems via passification. In *Proceedings of the American Control Conference*, volume 5, pages 2657–2661, Albuquerque, NM, June 4–6 1997.

[14] S. M. Joshi and A. G. Kelkar. Passivity-based control of elastic systems. In *Proceedings of the International Conference on Control Applications*, Hartford, Connecticut, October 5-7 1997.

[15] A. G. Kelkar and S. M. Joshi. On passivity-based control of flexible multibody nonlinear systems. In *Proceedings of the IEEE Conference on Decision and Control*, pages 4862–4867, Hyatt Regency, San Diego, CA,, December 10-12 1997.

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[17] A. G. Kelkar and Ding Ming. Neural network-based generalized predictive control of uncertain dynamic systems. In *Proceedings of the Fifth International Conference on Control, Automation, Robotics, and Vision*, pages 281–285, Mandarin Hotel, Singapore, December 8-11 1998.

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[20] P. Krishnaswami and A. G. Kelkar. The design of robustly controlled mechanical systems: an optimization perspective. In *Proceedings of the Conference on Optimization in Industry*, Banff, Canada, June 11-16 1999.

[21] Y. Mao, A. G. Kelkar, and S. M. Joshi. Synthesis of optimal constant-gain positive real controllers. In *Proceedings of the American Control Conference*, pages 273–277, San Diego, CA, June 2–4 1999.

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[23] F. Andreev, D. Auckly, L. Kapitanski, A. G. Kelkar, and W. N. White. Matching control laws for a ball and beam system. In *Proceedings of the IFAC Workshop on Lagrangian and Hamiltonian Methods for Nonlinear Control*, pages 161–162, Princeton University, Princeton, NJ, March 16-18 2000.

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[74] C. W. Whitmer, J. M. Vogel, A. G. Kelkar, D. Chaussee, and C. Ford. An efficient design tool for early-stage control-centric modeling, analysis, and trade studies for the next generation of hypersonic vehicles. In *Commercial and Government Response Access to Space Technology Exchange*, Moffett Field, CA, October 25-28 2010.

[75] J. Wang and A. G. Kelkar. Modeling, simulation, and control of active pneumatic suspension system. In *3rd Annual Dynamic Systems and Control Conference*, Marriott Boston Cambridge, Cambridge, Massachusetts, September 13-15 2010.

[76] A. G. Kelkar, J. M. Vogel, C. Whitmer, D. Chaussee, and C. Ford. Design tool for control-centric modeling, analysis, and trade studies for hypersonic vehicles. *17th AIAA International Space Planes and Hypersonic Systems and Technologies Conference*, April 11-14 2011. Grand Hyatt, San Francisco, CA.

[77] S. Nielsen, B. Steward, R. Dudley, A. Kelkar, M. Monga, and J. Zambreno. Enhancing realism and flexibility of vr-based real-time dynamic simulation framework with operator and hardware in-the-loop interface. In *2010 JD Enterprise Electronics Conference*, Convention Center, Waterloo, IA., September 28-29 2010.

[78] P. Tulpule and A. Kelkar. Integrated robust optimal design (irod) for quality improvement and cost reduction in product development. In *2010 JD Enterprise Electronics Conference*, Convention Center, Waterloo, IA., September 28-29 2010.

[79] C.E. Whitmer, A.G. Kelkar, J.M. Vogel, D. Chaussee, C. Ford, and U. Vaidya. Modeling and characterization of the impact of control surface free-play on flutter for an all moving surface. In *American Control Conference*, pages 5342 – 5347, Montreal, Canada, June 27-29 2012.

[80] W. D. Robinson and A. G. Kelkar. Modeling and identification of a pneumatic air spring-valve-accumulator system for semi-active suspension control. In *2012 ASME Dynamic Systems and Control Conference*, Hilton Fort Lauderdale Marina Hotel, Fort Lauderdale, FL, October 17-19 2012.

[81] P. Tulpule and A. G. Kelkar. Robust optimal control design using sensitivity dynamics and youla parameterization. In *2012 ASME Dynamic Systems and Control Conference*, Hilton Fort Lauderdale Marina Hotel, Fort Lauderdale, FL, October 17-19 2012.

[82] A. D. Shuttleworth and A. G. Kelkar. Toward a multi-objective, multi-level optimization based engineering decision tool. In *ASME 2012 International Mechanical Engineering Congress and Exposition*, Houston, Texas, November 9-15.

[83] W. D. Robinson, A. G. Kelkar, and J. M. Vogel. Semi active control methodology for vibration isolation using air spring-valve-accumulator system. In *2013 ASME Dynamic Systems and Control Conference*, Stanford University, Munger Center, Palo Alto, CA, October 21-23 2013. Invited paper (submitted).

<u>Selected</u> Invited Papers/Talks

[1] A. G. Kelkar and S. M. Joshi. Globally stable maneuvers of flexible space robots. In *Fourth International Conference on Control, Automation, Robotics, and Vision (***Invited Paper***)*, volume 1, pages 167–171, Westin Stamford, Singapore, December 3-6 1996.

[2] S. M. Joshi and A. G. Kelkar. Inner loop control of supersonic aircraft in the presence of aeroelastic modes. In *IEEE Conference on Control Applications (***Invited Paper***)*, Dearborn, Michigan, September 15-18 1996.

[3] W. N. White, A. G. Kelkar, and R. Fales. A hydraulically actuated compound pendulum. In *IEEE Conference on Control Applications (***Invited Paper***)*, Dearborn, Michigan, September 15-18 1996.

[4] A. G. Kelkar and S. M. Joshi. On passivity-based control of flexible multibody nonlinear systems. In *IEEE Conference on Decision and Control (***Invited Paper***)*, pages 4862–4867, Hyatt Regency, San Diego, CA,, December 10-12 1997.

[5] A. G. Kelkar and S. M. Joshi. Robust control of non-passive systems via passification. In *American Control Conference (***Invited Paper***)*, volume 5, pages 2657–2661, Albuquerque, NM, June 4–6 1997.

[6] S. M. Joshi and A. G. Kelkar. Passivity-based control of elastic systems. In *International Conference on Control Applications (***Invited Paper***)*, Hartford, Connecticut, October 5-7 1997.

[7] A. G. Kelkar. On the dynamics and control of flexible multibody nonlinear space systems. **Invited Talk** in *Multi-body Dynamics: New Techniques and Applications, ImechE HQ*, London, December 10-11 1998.

[8] A. G. Kelkar and S. M. Joshi. Robust passification and control of non-passive systems. In *American Control Conference (***Invited Paper***)*, pages 3133–3137, Adam's Mark Hotel, Philadelphia, PA, June 24-26 1998.

[9] S. M. Joshi and A. G. Kelkar. Robust passification via optimal sensor blending and control allocation. In *American Control Conference (***Invited Paper***)*, pages 278–282, San Diego, CA, June 2–4 1999.

[10] Y. Mao, A. G. Kelkar, and S. M. Joshi. Synthesis of optimal constant-gain positive real controllers. In *Proceedings of the American Control Conference (***Invited Paper***)*, pages 273–277, San Diego, CA, June 2–4 1999.

[11] S. M. Joshi, D. E. Cox, and A. G. Kelkar. Robust control of uncertain systems via norm-bounded lqg-type controllers. In *American Control Conference (***Invited Paper***)*, Chicago, IL, 28–30 June 2000.

[12] A. G. Kelkar, Y. Mao, and S. M. Joshi. Lmi-based passification for control of non-passive systems. In *American Control Conference (***Invited Paper***)*, Chicago, IL, 28–30 June 2000.

[13] D. Auckly, L. Kapitanski, A. G. Kelkar, and W. N. White. Matching and digital control implementation for underactuated systems. In *American Control Conference (***Invited Paper***)*, Chicago, IL, June 28-30 2000.

[14] F. Andreev, D. Auckly, L. Kapitanski, A. G. Kelkar, and W. N. White. Matching, linear systems, and the ball and beam. In *IFAC Workshop on Lagrangian and Hamiltonian Methods for Nonlinear Control (**Invited Paper**)*, Princeton University, Princeton, NJ, March 16-18 2000.

[15] A.G. kelkar and H. R. Pota. Robust broadband control of acoustic duct. In *2000 IEEE International Conference on Control Applications (presented as an **Invited Paper**)*, Anchorage, Alaska, Sept. 25-27 2000.

[16] A. G. Kelkar. Passivity-based robust control. **Invited Talk** presented at John Deere and Co., Dubuque, Iowa, April 2001.

[17] A. G. Kelkar. Passivity-based robust control. **Invited Talk** presented at Electrical and Computer Engineering, Iowa State University, April 6 2001.

[18] A. G. Kelkar and S. M. Joshi. An approach to acoustic noise control using passivity techniques. **Invited Talk** presented in IMECE, December 2001.

[19] Robust control: A passivity-based approach. **Invited Talk**, presented at Indian Institute of Technology, Bombay, Mumbai, India, December 13 2001.

[20] A. G. Kelkar. Control of dynamic systems using gpc and neural networks. **Invited Talk** presented at NASA Langley Research Center, June 2001.

[21] A. G. Kelkar. Passivity-based robust control and integrated design of controlled dynamic systems. **Invited Talk** presented at Caterpillar, Peoria, IL, May 2001.

[22] A. G. kelkar. Robust control of aerospace systems: A passivity-based approach. **Invited Talk** (seminar) presented at Aerospace Engineering and Engineering Mechanics, Iowa State University, November 1 2001.

[23] A. G. Kelkar. Overview of research and teaching at iowa state university. **Invited Talk** at Sauer-Danfoss, Ames, Iowa, September 2002.

[24] A. G. Kelkar. Active feedback control of acoustic noise. **Invited Talk** presented at Hon Industries, Muscatine, Iowa, April 2003.

[25] A. G. Kelkar. Active vibration isolation using pneumatic suspension. **Invited Talk** presented at Sears Seating Co., Davenport, Iowa, July 2004.

[26] A. G. Kelkar. Robust broadband control of acoustic noise - a passivity-based approach. **Invited Talk** presented at Centre for Ships and Ocean Structures, Marine Technology Center, Norwegian University of Science and Technology, Trondheim, Norway, June 2004.

[27] A. G. Kelkar. Overview of research in vibration and noise control at iowa state university. **Invited Talk** at Fisher Controls, Marshall Town, Iowa, March 2004.

[28] A. G. Kelkar. Vibration and noise control. **Invited Talk** at Vermeer, Pella, Iowa, May 2004.

[29] A. G. Kelkar: Control System Design for Jupiter Icy Moons Orbiter (JIMO) a Prometheus 1 Spacecraft, **Invited Talk**, Presented at Joint ASME CIS-ISU Meeting Gold Room, Memorial Union Iowa State University October 25, 2005.

[30] A. G. Kelkar and D. Soloway:Spacecraft Dynamics and Control - Overview of experience and capabilities, **Invited Talk**, Presented at Northrup Gruman Space Technology Directorate, Pasedena, CA, April 2005.

[31] A. G. Kelkar and J. M. Vogel: Aircraft Control Augmentation and Health Monitoring using FADS Technology, **Invited Talk**, Presented at Dryden Flight Research Center Edwards, CA 93523 June 27, 2006.

[32] A. G. Kelkar and J. M. Vogel:Aircraft Control Augmentation and Health Monitoring using FADS Technology, **Invited Talk** Presented at Air Data Systems Center of Excellence Sensor Systems, Goodrich Corporation 14300 Judicial Road Burnsville, MN 55306, 2006.

[33] A. G. Kelkar and J. M. Vogel: Pneumatic Isolation Technology, **Invited Talk**, presented at Link Manufacturing, Souix Center, Iowa, 2006.

[34] A. G. Kelkar: FADS-Based Reconfigurable Control and Health Monitoring for Hypersonic Vehicles, **Invited Talk** presented at Hypersonic NRA Kick-Off Meeting NASA Glenn Research Center Cleveland, OH April 24-25, 2007.

[35] Christopher E. Whitmer and Atul G. Kelkar. Piezo polymer Films for enhanced acoustic transmission loss and absorption. **Invited Paper** presented at 1st Annual Dynamic Systems and Control Conference, Ann Arbor, Michigan, USA, October 20-22 2008.

[36] A. G. Kelkar. Development of Control-Relevant Hypersonic Vehicle Modeling, Analysis, and Design Environment, **Invited Talk** presented at NASA Hypersonics Project, NRA Kickoff Meeting, San Antonio, TX, January 23-25, 2008.

[37] A. Kelkar, J. Vogel, G. Inger, and C. Whitmer. Development of controls modeling tools for airbreathing hypersonic vehicles. **Invited Talk** presented at *NASA Fundamental Aeronautics Conference*, Atlanta, GA, September 29 - October 1, 2009.

[38] J. M. Vogel, A. G. Kelkar, G. Inger, C. Whitmer, A. Sidlinger, and A. Rodriguez: Control-relevant modeling of hypersonic vehicles. **Invited Paper** presented at 2009 American Control Conference, St. Louis, MO, USA, June 10-12 2009.

[39] A. G. Kelkar: An efficient design tool for early-stage control-centric modeling, analysis, and trade studies for the next generation of hypersonic vehicles. **Invited WebEX Seminar** presented to NASA Hypersonics Project Team, July 8, 2010.

[40] A. G. Kelkar: Integrated Robust Optimal Design (IROD) for Quality Improvement and Cost Reduction in Product Development, **Invited Talk**, Presented at 2010 John Deere Enterprise Electronics Conference Waterloo, IA, September 28, 2010.

[41] J. M. Vogel and A. G. Kelkar. Stability augmentation and health monitoring for hypersonic vehicles using flush air data system feedback. In *Commercial and Government Response Access to Space Technology Exchange*, Moffett Field, CA, October 25-28 2010.

[42] A. G. Kelkar, C. W. Whitmer, J. M. Vogel, D. Chaussee, and C. Ford. Parametric trade studies and optimization of early-stage hypersonic vehicle design. In *Commercial and Government Response Access to Space Technology Exchange*, Moffett Field, CA, October 25-28 2010.

[43] C. W. Whitmer, J. M. Vogel, A. G. Kelkar, D. Chaussee, and C. Ford. An efficient design tool for early-stage control-centric modeling, analysis, and trade studies for the next generation of hypersonic vehicles. In *Commercial and Government Response Access to Space Technology Exchange*, Moffett Field, CA, October 25-28 2010.

[44] A. G. Kelkar, Stability Augmentation and Health Monitoring of Aircrafts Using Innovative Sensory Feedback. Invited seminar, Texas Tech University, Lubbok, TX, May 25, 2011.

[45] A. G. Kelkar, Modeling, Simulation, and Integrated Design of Complex Dynamic Systems - Challenges, Benefits, and Trends. Keynote Speaker, Turing100 - International Conference On Computing Sciences (ICCS); at Lovely Professional University, Phagwada, India, 14-15 September, 2012.

[46] A. G. Kelkar Innovative Methodologies for Sensing, Monitoring, and Control of Aerodynamic and Structural Health of Aircraft. Invited talk at NASA Langley Research Center, , March 2012.

[47] A. G. Kelkar Development of Tools and Methods for Characterizing the Impact of Control Surface Free-Play on Flutter Invited talk at NAVAIR, Patuxent River, MD, May 9, 2012.

Extramural Funding:
(**Total funding:** over $8 MM)

44 Amount: **$150,000** Agency: **NSF** Investigators: **C, Whitmer and A. G. Kelkar** Duration: 10/12 - 4/13 Title: A Collaborative Aerospace Vehicle Design Game in Support of Engineering Curricula for Grades 9-12

44 Amount: **$500,000** Agency: **NAVAIR** Investigators: **Jerald Vogel and A. G. Kelkar** Duration: 7/12 - 10/13 Title: Development of Tools and Methods for Characterizing the Impact of Control Surface Free-Play on Flutter

45 Amount: **$22,000** Agency: **NASA EPSCoR** Investigators: **A. G. Kelkar** Duration: Dec 1, 2011- June 30, 2012 Title: Iowa NASA EPSCoR Fellowship and Travel Award - Enhancing Aviation Safety and Efficiency Using an Innovative Sensory Feedback.

45 Amount: **$362,155** Agency: **DEERE and Company** Investigators: **A. G. Kelkar** Duration: 1/11-1/14 Title:Augmentation - Enhancing Integrated Robust Optimal Design (IROD) Environment for Integration of Off-the-Shelf Simulation Tools, User Friendliness, and Expanded Capabilities

44 Amount: **$69,984** Agency: **NAVAIR** Investigators: **Jerald Vogel and A. G. Kelkar** Duration: 8/10-1/11 Title: Development of Tools and Methods for Characterizing the Impact of Control Surface Free-Play on Flutter

43 Amount: **$148,682** Agency: **DEERE and Company** Investigators: **A. G. Kelkar** Duration: 1/08-1/11 Title:Augmentation - Integrated Robust Optimal Design (IROD) for Quality Improvement and Cost Reduction in Product Development

44 Amount: **$143,816** Agency: **State of Iowa** Investigators: **A. G. Kelkar** Duration: 7/08-6/09 Title: Waste Plastics, Crude Oil Sludge, and Tar Sand to Diesel - Capturing Energy from Waste

44 Amount: **$1,606,561** Agency: **NASA** Investigators: **Jerald Vogel and A. G. Kelkar** Duration: 1/08-1/11 Title:Control-Relevant Hypersonic Vehicle Modeling, Analysis, and Design Environment

43 Amount: **$194,848**   Agency: **DEERE and Company**   Investigators: **A. G. Kelkar**   Duration: 1/08-1/11   Title:Integrated Robust Optimal Design (IROD) for Quality Improvement and Cost Reduction in Product Development

42 Amount: **$371,384**   Agency: **DEERE and Company**   Investigators: **A. G. Kelkar and B. Steward**   Duration: 1/08-1/11   Title:Enhancing Realism and Flexibility of VR-Based Real-Time Dynamic Simulation Framework with Operator and Hardware in-the-loop Interface

41 Amount: **$623,125**   Agency: **NASA**   Investigators: **J. M. Vogel and A. G. Kelkar**   Duration: 1/07-12/09   Title:FADS-Based Reconfigurable Control and Health Monitoring of Hypersonic Vehicles

40 Amount: **$70,000**   Agency: **NASA**   Investigators: **J. M. Vogel and A. G. Kelkar**   Duration: 1/06-12/06   Title:Aircraft Control Augmentation and Health Monitoring using FADS Technology

39 Amount: **$32,480**   Agency: **Iowa State University Research Foundation**   Investigators: **A. G. Kelkar (P.I.)**   Duration: 3/07-9/07   Title: Enhancement of the Pneumatic Motion Damping Device for Vibration Isolation Systems

38 Amount: **$38,817**   Agency: **John Deere Co.**   Investigators: **A. G. Kelkar (P.I.)**   Duration: 1/07-3/07   Title: Real-Time Dynamic Simulation of JD Gator in a Virtual Environment with Hardware and Operator in the loop

37 Amount: **$50,000**   Agency: **Iowa Biotechnology Consortium**   Investigators: **R. Larock and A. G. Kelkar (Co-P.I.)**   Duration: 5/06-5/07   Title: Development Of Bioplastic Composites Using Ag Byproduct Fillers

36 Amount: **$73,919**   Agency: **ISU**   Investigators: **A. G. Kelkar (P.I.)**   Duration: 1/06-1/07   Title: Pneumatic Continuously Variable Natural Frequency and Damping Isolator for Active Suspensions

35 Amount: **$392,032**   Agency: **NASA**   Investigators: **A. G. Kelkar (P.I.)**   Duration: 6/04-5/07   Title:Assessment of Flexible Body Dynamics and Attitude and Articulation Control System for Jupiter Icy Moons Orbiter Class of Spacecraft

34 Amount: **$456,881**   Agency: **NSF**   Investigators: A. Chandra, **A. G. Kelkar (Co-P.I.)**, A. Bastawros Duration: 8/03-7/06 Title: Modeling and Control of Wafer-Scale Yield Improvement in Chemical Mechanical Polishing

33 Amount: **$435,888**   Agency: **Deere and Company**   Investigators: **A. G. Kelkar (P.I.), B. Steward**   Duration: 1/05-01/08   Title: Development of Optimal and Robust Control Design Methodologies for Real-Time Control of Machines in Virtual Environment.

32 Amount: **$115,040**   Agency: **NASA**   Investigators: **A. G. Kelkar (P.I.)**   Duration: 9/03 - 5/06   Title:Development of Unified Control Architecture for Guidance, Navigation, Reconfigurability and Collision Avoidance for Future Aerospace Systems.

31 Amount: **$219,137**   Agency: **NASA**   Investigators: **A. G. Kelkar (P.I.)**   Duration: 2/01-1/04   Title:An Integrated Approach to Noise Control with Applications to Aircraft Cabins.

30 Amount: **$270,029** Agency: **NSF** Investigators: **A. G. Kelkar (P.I.)** Duration: 6/03-5/06 Title:Development of Global Feedback Control Strategies for Silencing Noise.

29 Amount:**$212,024** Agency: **NASA** Investigators: **A. G. Kelkar (P.I.)** Duration: 1/01-12/04 Title:Verification of Controllers Based on Adaptive Neural Networks.

28 Amount: **$50,741** Agency: **Sauer-Danfoss** Investigators: **A. G. Kelkar (P.I.)** Duration: 3/03-2/05 Title: Development of Systems Tools for Sauer-Danfoss Products.

27 Amount: **$12,000** Agency: **Iowa Space Grant Consortium** Investigators: **A. G. Kelkar (P.I.)** Duration: 2/02-01/03 Title: Development of Robust Control Strategies for Aerospace Systems

26 Amount: **$19,000** Agency: **Iowa State University** Investigators: **A. G. Kelkar (P.I.)** Duration: 1/02-12/02 Title:Control Methodology Development for Silencing Noise

25 Amount: **$205,331** Agency: **Deere and Company** Investigators: **A. G. Kelkar (P.I.)** Duration: 1/02-01/05 Title: Development of Optimal and Robust Control Design Methodologies for Real-Time Control of Machines in Virtual Environment.

24 Amount: **$310,000** Agency: **NSF** Investigators: **A. G. Kelkar (P.I.)** Duration: 6/97-5/01 Title:Robust Control of Passive and Non-Passive Aerospace Systems (CAREER AWARD).

23 Amount: **$100,000** Agency: **Boeing** Investigators: **A. G. Kelkar (P.I.)** Duration: 6/98-5/02 Title: Industry Sponsored Education Program.

22 Amount: **$305,604** Agency: **NSF** Investigators: **A. G. Kelkar (P.I.)** Duration: 11/00-10/03 Title:Energy Extraction-Based Feedback Control Methods For Silencing Noise.

21 Amount: **$282,573** Agency: **NSF** Investigators: **A. G. Kelkar (P.I.)** Duration:09/98-08/01 Title: Control of Underactuated, Nonlinear, Non-holonomic, Mechanical Systems.

20 Amount: **$9,132** Agency: **NASA** Investigators: **A. G. Kelkar (P.I.)** Duration: 8/01-6/02 Title: Synthesis Methods for Robust Passification and Control II.

19 Amount: **$24,919** Agency: **NASA** Investigators: **A. G. Kelkar (P.I.)** Duration:3/00-9/00 Title:Predictive and Neural Predictive Control of Uncertain Systems

18 Amount: **$12,198** Agency: **NASA** Investigators: **A. G. Kelkar (P.I.)** Duration: 1/01-2/03 Title:Predictive and Neural Predictive Control of Uncertain Systems - II.

17 Amount:**$750** Agency: **KSU** Investigators: **A. G. Kelkar (P.I.)** Duration:1/00-12/00 Title:Faculty Development Award.

16 Amount:**$15,000** Agency: **AMI-KSU** Investigators: **A. G. Kelkar (P.I.)** Duration: 5/00-5/01 Title: Analysis and Control of Errors in Robotic Machining.

15 Amount: **$12,500** Agency: **NASA** Investigators: **A. G. Kelkar (P.I.)** Duration:6/99-5/00 Title: Synthesis Methods for Robust Passification and Control of Linear, Time-invariant(LTI) Systems.

14 Amount: **$21,885** Agency: **NASA** Investigators: **A. G. Kelkar (P.I.)** Duration: 6/99-6/00 Title:Further Investigation of Receding Horizon-Based Controllers and Neural Network-Based GPC Control Systems.

13 Amount: **$115,875** Agency: **NASA** Investigators: **A. G. Kelkar (P.I.)** Duration:4/96-4/99 Title:Passivity-Based Control of Aerospace Systems.

12 Amount: **$127,618** Agency: **NASA** Investigators: **A. G. Kelkar (P.I.)** Duration: 5/96-5/99 Title:Generalized Predictive and Neural Generalized Predictive Control of Aerospace Systems.

11 Amount: **$1500** Agency: **KSU** Investigators: **A. G. Kelkar (P.I.)** Duration: 97-98 Title:Faculty Development Award.

10 Amount: **$18,000** Agency: **Kansas Space Grant Consortium** Investigators: **A. G. Kelkar (P.I.)** Duration: 3/96-2/98 Title: Passivity-Based Tracking Control of Spacecraft.

 9 Amount: **$1500** Agency: **KSU** Investigators: **A. G. Kelkar (P.I.)** Duration: 96-97 Title:Faculty Development Award.

 8 Amount: **$69,000** Agency: **NASA** Investigators: **A. G. Kelkar (P.I.)** Duration: 1/92-12/93 Title:Advanced Control Law Designs for Flexible Spacecraft.

 7 Amount: **$5,050** Agency: **NASA** Investigators: **A. G. Kelkar (P.I.)** Duration: 8/92-12/92 Title:Identification and Design of Nonlinear Control Systems Using Real-Time Neural Network.

 6 Amount: **$65,475** Agency: **NASA** Investigators: **A. G. Kelkar (P.I.)** Duration: 1/91-12/92 Title:Mathematical Modeling and Control of Flexible Spacecraft Systems.

 5 Amount: **$59,996** Agency: **NASA** Investigators: **A. G. Kelkar (P.I.)** Duration: 11/90-12/91 Title:Modeling and Control for Articulated Flexible Space Structures.

 4 Amount: **$25,970** Agency: **NASA** Investigators: **A. G. Kelkar (P.I.)** Duration:6/90-12/90 Title: Modeling and Control for Articulated Flexible Space Structures.

 3 Amount: **$2,394** Agency: **Glycon, L.L.C.** Investigators: **A. G. Kelkar (P.I.)** Duration:7/04-8/04 Title: Measurement and Analysis of Data to Characterize PZT Sensors.

 2 Amount: **$2358** Agency: **ISU Research Park** Investigators: **A. G. Kelkar (P.I.)** Duration:7/04-8/04 Title: Measurement and Analysis of Data to Characterize PZT Sensors.

 1 Amount: **$2,236** Agency: **Glycon, L.L.C.** Investigators: **A. G. Kelkar (P.I.)** Duration:9/04-10/04 Title: Measurement and Analysis of Data to Characterize RAA1S1400 EMFIT Sensors.

Interdisciplinary Activities:

Dr. Kelkar's interdisciplinary activities include a complementary blend of research, education, and technology transfer activities. These activities span from fundamental research to applied engineering as well as from academia-industry partnership in undergraduate education to commercialization of bio-composite and technology products. Given below is a brief account of past accomplishments and on-going efforts in various multidisciplinary areas:

◇ Collaboration with Chemistry (Dr. Larock):

   Project: "Development Of Bioplastic Composites Using Ag Byproduct Fillers," Iowa Biotechnology Consortium, 9/06-9/07, $50,000.

The focus of this research effort was on the development of new bio-composites made out of corn and soybean which can be used in vibration damping and noise mitigation technology. Project focused on the preparation and complete characterization of a wide range of soybean and corn oil bioplastic composites, agricultural byproducts dried distillers grains (DDGs), corn gluten feed, soy hulls, and other agricultural waste materials. The primary objectives were to (1) increase the value of these raw materials, (2) expand the use of biorenewables, while conserving nonrenewable petroleum, and (3) enhance the profitability of American agriculture by developing exciting new soybean and corn oil-based plastic composites possessing tremendous industrial potential for the dampening of sound and vibration.

◇ Collaboration with Physics:

Project: J. Shinar, R. Shinar, and A. G. Kelkar: "Compact Low-Cost Sensors for Gas-Phase and Dissolved Oxygen," (NSF SBIR funds).

The goal of this proposal is to accelerate the development and consequent commercialization of prototype gas-phase and dissolved oxygen sensors. The sensors are based on a new miniaturizable organic light-emitting device (OLED) platform. They contain a luminescent sensing element that is structurally integrated with its OLED light source in a uniquely simple manner that results in a very compact and cost-effective sensor module. The market for such sensors, which are needed for medical applications, the aerospace industry, wastewater management, food/brewing, and environmental/fishery applications, approaches $200M. The project involves collaborations between ISU and Iowa small businesses, ISTI and Vibroacoustics Solutions Inc (VSI).

◇ Collaboration with Ag and Biosystems Engineering:

Project: A. G. Kelkar and Brian Steward: "Development of Optimal and Robust Control Design Methodologies for Real-Time Control of Machines in Virtual Environment," Deere and Company, $435,888 (Jan. 05 - Jan. 08); $371,384 (Jan. 08-Jan.11)

This project is aimed at developing real-time simulation architecture in virtual environment with human and hardware -in-the-loop capability. The simulation is expected to have varying degree of fidelity as required by the application. The simulation architecture is expected to have modular plug-an-play type functionality. This simulation environment will allow Deere to rapid prototype new designs, assess human response in virtual environment, and drastically reduce the design, analysis, and development time and thereby enabling faster commercialization of the new machine.

◇ Collaboration with Business School:

Involved in activities related to campus-wide Entrepreneurship Minor. Participation in Entrepreneurship forums and conferences.

◇ Collaboration with CIRAS:

Dr. Kelkar interacts closely with CIRAS on different Iowa-based industry projects. Some recently finished successful projects involved ISU start-up VSI and MidAmerican utility company. Other projects under works include companies such as SwitchQuick, Link Mfg., Caterpillar, Sears Manufacturing, and Maytag.

◇ Collaboration with Aerospace Engineering:

Dr. Kelkar works with several Aerospace faculty on different research projects. Dr. Kelkar has been major professor as well as Co-Major professor for several Aerospace graduate students as well. He has some past and some ongoing collaborations with Dr. Vogel (now Professor Emeritus), Dr. Bastawros, Dr. Chavez (now at AFRL), and Dr. Partha Sarkar.

Project: A. Chandra, A. G. Kelkar, A. Bastawros: "Modeling and Control of Wafer-Scale Yield Improvement in Chemical Mechanical Polishing," $456,881, NSF, Duration: 8/03-7/06.

Project: Development of active pneumatic suspension system for seats, cabs, sleeper bunks, etc. (Grow Iowa Values Fund Project), $73,919, Duration:05/6-5/07. This project had active participation of small and large businesses with specific target of commercialization

Project: A. G. Kelkar and Frank Chavez: Development of morphing/segmented wing technology (Two M.S. students graduated, NASA NRA in-process).

◇ Collaboration with Electrical Engineering:

Dr. Kelkar has active collaboration with Electrical Engineering faculty as well. He has been active participant in joint controls seminar series, faculty recruitment, teaching courses across department, and research projects. He has and continues to work with Electrical faculty on research projects and proposals.

◇ Technology Transfer Activities:

Dr. Kelkar was involved in foundation of 4 (four) technology spin-offs from his research activities. Three of his 4 spin-off companies won state level awards during their nascent years. Primary goals of these start-ups has been to bring ISU-born technologies to market as well as develop new technologies in the areas of vibration and noise control, aerospace systems, and alternate energy. All of these companies have made outstanding progress in their infancy years by winning nationally competitive contracts, launching two products, and acquiring several industry contracts. The key accomplishments are as follows:

- Won nationally competitive NASA NRA contracts - the first one in Oct. 2006 ($550K) and second one in May 08 for $ 1.6 Million for Hypersonics research.
- Only Iowa company to win NSF Phase I SBIR in 2004 ($100K).
- Only Iowa company to win NSF Phase II SBIR in 2005 ($440K). Project is for development of smart active-passive composite for noise and vibration control.
- Only Iowa Company to win NASA Phase I SBIR in 2006 ($70K).
- Won NASA NRA Hypersonic contract in January 2007 ($623K)

- Won Third, Second, and First place price in statewide business plan competition in successive three years 2009-2011.

- Won NSF Phase I SBIR in 2012 for development of Educational Game

- Won NAVY Phase I ($ 100 K) and Phase II ($ 500K) STTR under Joint Strike Fighter Program.

- Launched two bio-based products in market:(1) Bio-degradable lubepaste, (2) Bio-based acoustical door cores.

- Employed 4 ISU graduates including 1 M.S. and 3 B.S. engineering majors.

- Established collaborative relationships with Maytag, Deere, Caterpillar, Sears Seating, Link Manufacturing, and MidAmerican Energy.

- Acquired engineering contract from RV manufacturer Dodgen industries to design and build molds for their new fleet of RVs.

Company has worked with CIRAS and IPRT on projects with Iowa companies and is in the process of licensing ISU's IP for some high tech product applications.

Professional Service Highlights:

National and International Service:

- *Editorial Activities:*
    1. Served as Associate Editor for leading ASME and IEEE control journals.
    2. Served on IEEE Conference Editorial Board over 4 years
    3. Served as Associate Editor for ASME Dynamic Systems and Control Division conference reviews

- *Committee Activities:*
    1. Operating Committee member for several key conferences
    2. Served on Program Committees for several international conferences

- *Organization and Panel Activities:*
    1. Panel Member for NSERC Evaluation Committee, January-February 2006.
    2. Organizer for several technical sessions and invited sessions for IEEE and ASME conferences
    3. Panel Chair over 4 years for Aerospace Systems panel for ASME DSCD Division
    4. Chaired and co-chaired numerous technical sessions in various conferences
    5. Student Best Paper Award Judging Panel

- *Review Activities:*
    1. Reviewer for numerous ASME, IEEE, and AIAA Journals
    2. Reviewer for NSF technical review panels
    3. Reviewer for various international conferences
    4. Invited reviewer for text books

University Service:

- Member of Special Task Force on salary compression.

College Service:

- Served on College of Engineering Research Awards Committee, Promotion and Tenure Committee.

Department Service:

- Served on various departmental committees and Chaired some of them: Faculty Search Committee, Enrollment management Committee, Curriculum Committee, Library Liaison for Department, Course Development Committee, Teaching Load Assessment Committee, Graduate Committee, Computer Committee, etc.

Other Service:

- Faculty advisor for student organizations at Kansas State University as well as Iowa State University
- Participation in high school (K-12) related activities

Professional Service Record:

National and International Professional Service:

The national and international level professional service activities include serving on technical review committees, organization and chairing of technical sessions at various scientific meetings, serving on technical panels, and serving on editorial boards of societies.

Membership:

Fellow, ASME, Associate Fellow, AIAA, Senior Member IEEE, Full Member, Sigma Xi, Member, ASEE.

Technical Panel Activities:

Chair, Technical Panel on Aerospace Systems, ASME Dynamic Systems and Control Division, 1997-2003.

Member, ASME Technical panel on Computer Communications and Control, 1997-present.

Member, ASME Technical panel on Vibration and Noise Control, 2003-present.

Editorial Service:

Associate Editor, IEEE Transactions on Control System Technology, May 2002- May 2009.

Associate Editor, ASME Journal of Dynamic Systems, Measurement, and Control, June 2004 - 2010.

Associate Editor, Conference Editorial Board (CEB), IEEE Control System Society, 1998-2005.

Member, International Editorial Committee, Foxwell and Davies Italia srl Scientific Publisher Via G. Verdi 3 80016 Marano di Napoli, Italy.

Program Committee Activities:

Finance Chair, 2014 ASME Dynamic Systems and Control Conference, Dallas, TX, 2014.

Students and Young Members Chair, 2013 ASME Dynamic Systems and Control Conference, Stanford University, Palo Alto, CA, 2013.

Vice Chair, Special Sessions/Interactive Sessions, Operating Committee, 2008 American Control Conference, June 12-14, 2008, The Westin Seattle, Seattle, WA.

Exhibits Chair, Operating Committee, 2006 IEEE Conference on Decision and Control, San Diego, California, December 2006.

Exhibits Chair, Operating Committee, 2005 American Control Conference, Portland, Oregon, June 8-10, 2005.

International Program Committee Member, IASTED International Conferences on Intelligent Systems and Control, 2001-present.

Program Committee Member, 1998-2002, 2006, American Control Conference

Served on the panel of judges for the selection of the Best Student Paper award for 1998 and 1999 American Control Conference.

Organizational Activities (selected list):

Session Chair, Session TA3- Control Systems II, Advances in Control and Optimization of Dynamical Systems (ACODS), IISc, Bangalore, India, February 1-2, 2007.

Topical Organizer for Aerospace Systems area. ASME International Mechanical Engineering Congress and R&D Exposition, 2003-2006.

Session Chair for the session DSC-18A Aerospace Systems, 2003 ASME International Mechanical Engineering Congress and R&D Exposition, Washington, D.C., November 15-21, 2003.

Session Co-Chair for the session DSC-6 Vibration control of vehicle suspension systems, 2003 ASME International Mechanical Engineering Congress and R&D Exposition, Washington, D.C., November 15-21, 2003.

Co-Chair for the session DSC8-C entitled "Active Control of Vibrations III", 2002 International Mechanical Engineering Congress and Exposition, November 17 – 22, 2002, New Orleans, Louisiana.

Organizer and Co-Chair for the session on "Control of Acoustic Noise," IEEE International Conference on Control Applications, Anchorage, Alaska, Sept. 25-27, 2000.

Organizer for the invited session on "Control of Nonlinear Underactuated Systems", 2000 American Control Conference, Chicago, IL, June 28-30, 2000.

Organizer and Co-Chair for the invited session on "Advances in Dissipativity-Based Control", 2000 American Control Conference, Chicago, IL, June 28-30, 2000.

Organizer of an invited session entitled: "Advances on Passivity-Based Control", 1999 American Control Conference (ACC), Hyatt Regency, San Diego, CA, USA, June 2-4, 1999. The session was organized on behalf of Aerospace Panel of ASME's Dynamic Systems and Control Division.

Co-organizer and Co-Chair of an invited session entitled " Passivity-Based Control Methods," 1997 American Control Conference (ACC), Albuquerque, NM, USA, during June 4-6, 1997. The session was organized on behalf of Aerospace Panel of ASME's Dynamic Systems and Control Division.

Organizer and Chair of the session entitled "Aircraft Dynamics, Control, and Simulation", in 1996 IEEE Conference on Control Applications, Dearborn, Michigan, September 15-18, 1996.

Organizer and Chair of the session entitled "Laboratory Experiments in Control Applications", in 1996 IEEE Conference on Control Applications, Dearborn, Michigan, September 15-18, 1996.

Co-Chaired the session entitled "Experimental Control of Flexible Structures," 1990 American Control Conference, San Francisco, CA, June 1993.

Review Committee Activities:

Reviewer for NSF panels since 1997. Reviewer of numerous technical papers for different journals and/or conferences. Partial list of these Journals/Conferences include: AIAA Journal of Guidance Control and Dynamics, ASME Journal of Dynamic Systems, Measurement, and Control, IEEE Trans. on Automatic Control, IEEE Trans. on Control System Technology, IEEE Tran. on Neural Networks, International Journal of Control, American Control Conference, ASME International Mechanical Engineering Congress and Exposition, IEEE Conference on Decision and Control, IEEE

Conference on Control Applications.

University Service Record:
Activities include: serving on various department, college, and university committees, undergraduate and graduate advising, active involvement in college/university service activities.

University Committees:
Special Task Force on Salary Compression, Spring 03-05.

College Committees:
Promotion and Tenure Committee, 2005-2008, 2009-present

Research Grants Committee, 2003-2006.

Department Committees:
Promotion and Tenure Committee, Fall 2005-present

Chair, Enrollment Management Committee, Fall 04-07

Chair, Course Development Committee (ME 421), Spring 2002-2005, 2012-present

ME Curriculum Committee, Fall 2002-2005

Library Liaison for ME, 2001-present

Engle Lab Committee, 2001

Member of Design Assessment Panel. Spring 2001, Fall 2001

Chair, Recruitment Committee, Spring 2004

Recruitment Committee, Fall 2001, Spring 2002, Fall 2002, Spring 2003

Ad-hoc committee on Teaching Load Assessment, Fall 2001

Graduate Committee, 96-99.

Scholarship Committee, 96-99.

Chair, Computer Committee, 98-00.

Undergraduate Committee, 99-00

Faculty Search Committee, 2000

Chair Search Committee, 2006, 2009

Faculty Advisor, Robotics Club (Fall '02 - present)
Responsibilities included meetings with student officers, identify and invite speakers, supervise and assist students in activities of the club such as raise funds, recruit members, and local/state/national level design competitions.

Faculty Advisor, ASME Student Chapter (Fall '97 - Fall '00)
Responsibilities included regular meetings with student officers, identify and invite seminar speakers, raise funds, recruit members, and assist students in Open House activities.

Faculty Advisor, NASA AGATE Student Design Team (Fall '96 - Fall '99)
Actively involved in the annual NASA AGATE Student Design Competition. Kansas AGATE Team won the 1st prize in the nation in '95, '97, and '98 and won the 2nd prize in '96. Responsibilities include advising students in all aspects of designing, manufacturing, and testing of prototype aircraft.

Teaching Highlights:

My noteworthy contributions in teaching related activities are summarized below:

Undergraduate Education:

- Taught courses at all levels from Freshman through Graduate over last 10 years. Always strived to maintain high quality of teaching through rigorous course content, fair evaluation process, and employing diverse teaching methods to cater to different learning types. Maintained open door policy for meeting with students for easy accessibility to students.

- Received training in Active Learning (AL) and Cooperative Team-Based Learning (CL) in 1997 through ASEE National Effective Teaching Institute workshop offered by father of active learning Dr. Richard Felder of North Carolina State University. Instituted AL and CL techniques in almost all courses since 1997.

- Under NSF CAREER Award developed a novel co-op like program at Kansas State University called "Industry Sponsored Education Program (ISEP)", for undergraduate curriculum that seamlessly integrates industry experience into core curriculum while fostering industry-university partnership at both education and research level. Acquired $100K support from Boeing, Wichita, KS for development of ISEP program. My aim is to develop a similar program at ISU within next 5 years.

- Encourage undergraduates to work in research laboratories by offering undergraduate research opportunities through ME 490 course credits. Typically, have 1 or 2 such students almost every semester in addition to normal teaching load.

- Advised an average of 30 undergraduate students each semester during 1996-2001 as no separate advising center was present at KSU.

Laboratory and Course Development:

- Developed undergraduate level technical elective courses. Developed and/or re-structured undergraduate laboratory in dynamics and controls area at all three universities Old Dominion University (MEM 436 and 438), Kansas State University (ME 640), and Iowa State University (ME 421).

- Developed several proof-of-concept research experiments that can be used for demonstration and special class projects for senior and graduate level technical elective courses.

Graduate Education:

- Developed graduate level courses and laboratories.
- Advised several graduate students.
- Served on several graduate students' Program of Study committees.
- Supported postdoctoral fellow for over 3 years.
- Hosted visiting scholars and faculty from foreign institutions for extended time.

Distance Education:

- Taught distance education courses ME 511 and ME 577.
- Advisor for several off-campus graduate students from Iowa industries.

Teaching Record:

- Courses Taught at *Iowa State University*

  ME 160X **Freshman**, Introduction to Mechanical Engineering, Fall 11, Spring 12, Fall 12.

  ME 418 **Senior**, Robot Dynamics and Control, Spring 06,Spring 07, Spring 09, Spring 11.

  ME/EE/AeroE/Math 577 **Senior/Graduate** Modern Control Systems, Fall 04

  ME 421 **Junior/Senior** Mechanical Systems and Control, Spring 01, Fall 02, Fall 05, Spring 09, Fall 09.

  ME 411 **Senior** Automatic Control, Fall 01, Fall 10, Fall 12.

  ME 511 **Graduate** Advanced Control Design, Spring 02, Spring 03, Spring 11, Spring 13.

- Courses Taught at *Kansas State University*

  ME 640, **Senior** Automatic Controls, Spring '96, Fall '96, Spring '97, Spring '98, Fall '00

  ME 732 **Graduate/Senior** Robotics, Fall '96, Fall '97

  ME 830 **Graduate** Multivariable Control, Spring '97, Fall '99

  ME 830 **Graduate** Robust Control, Fall '97

  ME 830 **Graduate** Optimal Control, Spring '98

  ME 570 **Senior** Mechanical System Dynamics, Fall '98, Fall '99

- Courses Taught at *Old Dominion University*

  MEM 696, **Graduate**, Optimal Control Theory, Spring '94

  MAE 650, **Graduate**, Modern Control Theory, Summer '94

  MEM 538/438, **Graduate/Senior**, Control System Design and Applications, Spring '94

  MEM 436, **Senior**, Dynamic Systems and Control, Fall 93, Spring '95

  MEM 205, **Sophomore**, Dynamics, Spring '94, Fall '94

  MEM 111, **Freshman**, Introduction to Computer-Aided Engineering, Fall '87

Graduate Advisees:
Currently supervising: 8 Ph.D. students

Doctoral Degree Students

	Name	Degree	Graduation	Employment
	Graduated:			
1	Y. Mao	Ph.D.	May '00	Hewlett Packard, CA
2	Roger Fales	Ph.D.	Spring '04	Faculty, Univ. of Missouri, Columbia
	(Teaching Excellence Award)			
3	Jianjun Shi	Ph.D.	Fall '05	NYU
4	Hemanth Porumamilla	Ph.D.	Fall, '07	CalPoly at San Luis Obispo
5	Chris Whitmer	Ph. D.	Spring '09	VSI Aerospace, Inc.
6	Pavankumar Karra	Ph. D.	Spring '09	Industry

7	Tom Waite	Ph.D.	Fall, '10	Signals Systems Corporation
8	Adam Shuttleworth	Ph.D.	Fall, '11	Deere and Company, Dubuque, IA
10	Jia Wang	Ph.D.	Fall, '11	Deere and Company, Des Moines, IA
11	William Robinson	Ph.D.	Summer '12	Deere and Company, Waterloo, IA
	Current:			
1	Punit Tulpule	Ph.D.	Fall, '13	
2	David Asjes	Ph.D.	Fall, '13	
3	Rachel Dudley	Ph.D.	Fall, '12	
4	Eric Anderson	Ph.D.	Fall, '12	Deere and Company, Dubuque, IA
5	Nick Clinkinbeard	Ph.D.	Fall '13	Rockwell Collins, IA
6	Ruchir Goswami	Ph.D.	Fall '14	
7	Kalyan Kappagantula	Ph.D.	Took break	Company in Peoria, IL
8	Zachery Kemp	Ph.D.	Fall '14	Deere and Company, NC

Masters Degree Students

	Graduated:			
1	Liu Feng	M.S.	Fall '02	Purdue University
2	Kevin Kruck	M.S.	Fall '02	Lockheed Martin, St. Louis, MO
3	Jason Carrigan	M.S.	Spring '03	Etrema, IA
4	Chris Whitmer	M.S.	Fall '03	Research Park, Ames, IA
	(Research Excellence Award)			
5	Yang Xu	M.S.	Summer '03	industry job in Texas
6	Eric Spencer	M. S.	Summer '04	industry job in CA
7	Hemanth Porumamilla	M.S.	Fall, '03	Faculty in CalPoly
8	Dennis Griffin	M. S.	Fall '03	Aerospace company
9	Tom Waite	M.S.	Summer '06	Signals Systems Corp.
10	Nick Clinkinbeard	M. S.	Summer '04	Rockwell Collins, IA
11	Chris Metschke	M. S.	Spring, '07	Fisher Controls, IA
12	Travis V. DuBois*	M.S.	May '94	industry job in Boston
13	Ding Ming	M.S.	May '98	industry job in California
14	S. Rangarajan	M.S.	April' 00	Microstrategy, Inc.
15	Shekhar Gosavi	M.S.	May '00	industry job in Texas
16	Shilpa Vaze	M.S.	Spring '02	Schlumberger, TX
17	Kalyan Vladimani*	M.S.	Fall. '02	
	Current:			
1	Yi Zhang	M. S.	Spring '14	
2	Hui Zhou	M. S.	Spring '14	
3	Michael Romney	M. S.	Spring '14	

∗ Co-advisor

Postdoctoral Fellows and Visiting Scholars:

1. **Dr. Bo Fang**, Postdoctoral Fellow, Dept. of Mechanical Engineering, Shenyang University, China, Fall 00- present.

2. **Dr. Himanshu R. Pota**, Associate Professor, University of New South Wales, Canberra, Australia. March 1999-December 2000, April 2001-June 2001, July 2002.

3. **Dr. Girijesh Prasad**, Assistant Professor, University of Ulster, Londonderry, N. Ireland, United Kingdom, Summer 2000.

Development of New Internship Program

As a part of NSF CAREER Award, Dr. Kelkar developed a novel internship program entitled "Industry-Sponsored Education Program (ISEP)," which integrates industry experience with undergraduate curriculum in a very structured and systematic way. ISEP involves an active involvement of faculty in interns' industry projects. ISEP promotes close, three-way interaction between faculty, students, and industry. Unlike existing co-op programs, in ISEP, students spend extended time (total of 10 months) in industry in two phases and get credit for their project work. ISEP also opens doors of opportunity for faculty-industry collaborations in the technical areas of mutual interests.

The basic motivation behind establishing ISEP was to incorporate industrial ("real-world") experience into undergraduate curriculum as a part of graduation requirement. The structure of this program is quite different from traditional co-op programs. In this program, students earn up to 6 credits by working on a industry project approved jointly by industry and faculty supervisors. Unlike existing co-op, in ISEP program faculty is engaged not only in the selection process of the students but also in monitoring the progress of the students while at industry. As a part of the program faculty advisor also spends few weeks of summer in industry to help students and simultaneously develop research ties with industry. Students' training in industry is divided into two phases. In the first phase students spend the 3 months in summer after their sophomore year and in the second phase they spend 7 months (summer plus fall) after their junior year.

The benefit to industry is that they can recruit their potential employees well ahead of time and train them at lower cost. The benefit to students is that they have option to continue their job after graduation with the same company if mutually acceptable or else they have strong industrial experience which increases their marketability.

The pilot phase of the program has been successfully implemented with Boeing, Wichita, KS, as the industry partner. Having successfully completed the pilot phase of the program, ISEP is ready to expand to more companies, more departments, and more students. The program has been so successful that Boeing, Wichita is now looking for expanding this program to other universities with Dr. Kelkar's assistance.

Lab and Course Development

- Developed new lab for ME 438 (Control Systems Applications - senior/graduate) and restructured entire lab for ME 436 (Dynamic Systems and Control - required course at senior level) at ODU.

- Designed and developed new experiments for ME 640 (Automatic Controls- required senior

level) and ME 732 Robotics lab (graduate) at KSU. 732

- Developed several graduate level courses: Robust Control, Optimal Control, Multi-variable Control, Passivity-based Control, Predictive Control.
- Renovation of ME 421 (Mechanical Systems and Control - required senior level) laboratory to upgrade data acquisition hardware, selected lab experiments, and laboratory manual.
- Development of lab for ME 411 (technical elective - senior/graduate)