

# Curriculum Vitae

J. Kenneth Salisbury, Jr.

February 20, 2021

Professor (Research)

Depts. of Computer Science & Surgery

Schools of Engineering & Medicine

Stanford University

Stanford, CA 94305

## 1. Academic History

<b>School</b>	<b>Degree</b>	<b>Date</b>
Stanford University	B.S. (Electrical Engineering)	Jun 1975
Stanford University	M.S. (Mechanical Engineering)	Dec 1977
Stanford University	Ph.D. (Mechanical Engineering)	Jun 1982

## 2. Principal Fields of Interest

Design and Control of Electro-mechanical Systems ; Kinematics; Robotics; Robot hands; Haptics; Telerobotics; Human/Machine Interfaces; Medical Robotics; Surgical Simulation.

## 3. Non-Academic Experience:

<b>Employer</b>	<b>Position</b>	<b>Beginning</b>	<b>Ending</b>
Hewlett-Packard, APD	R&D Engineer	Jun 1973	Sep 1974
NASA/Ames Research Center	Research Assistant	Jul 1975	Aug 1976
SRI International	Research Engineer	Oct 1976	Aug 1977
Salisbury Robotics, Inc.	President and Founder	Jun 1982	May 1997
Intuitive Surgical, Inc.	Fellow and Scientific Advisor	Sep 1997	Apr 2003
Robotic Ventures Fund	Technical Advisor	Nov 2000	Jan 2003
Auris, Inc.	Technical Advisor	June 2009	Jan 2011

4. Academic Experience:

<b>Employer</b>	<b>Position</b>	<b>Beginning</b>	<b>Ending</b>
Stanford University, A.I. Lab.	Research Assistant	Oct 1977	Jun 1982
MIT, M.E. Dept.	Lecturer	Sep 1985	Jun 1991
MIT A.I. Lab.	Research Scientist	Oct 1982	Jun 1991
MIT, M.E. Dept.	Principal Research Scientist	Jul 1991	Dec 2000
Stanford University	Visiting Scholar	Jun 1999	Jul 1999
Stanford University	Acting Professor (Research)	Sep 1999	Aug 2000
Stanford University	Professor (Research) Jointly in Computer Science and Surgery	Sep 2000	Nov 2017
Stanford Dept of Surgery	Co-Director, CATSS Lab	Sep 2000	Jun 2002
Stanford Dept of Mech. Engr.	Professor, by Courtesy	Sep 2002	Nov 2017
Stanford Dept of Surgery	Co-Director, BioRobotics Lab	Oct 2003	Jan 2016
Amrita Univ., Kollam, India	Adjunct Professor	Aug 2011	present
Stanford Depts. of Surgery and Computer Science	Professor Emeritus	Nov 2017	present

5. Consulting Record:

<b>Firm</b>	<b>Beginning</b>	<b>Ending</b>
NASA/JPL	Aug 1978	1989
GTE Laboratories	Nov 1981	(1 day)
Thinking Machines Corp.	Nov 1984	(1 day)
General Motors	May 1984	(1 day)
Arthur D. Little Corporation	May 1985	Apr 1988
Rockwell International Corp.	Apr 1986	(1 day)
ILC Space Systems	May 1987	(2 days)
Grumman Aerospace Corp.	Oct 1988	(3 days)
Intelligent Automation Systems	Apr 1990	(2 days)
Transitions Research Corp.	Oct 1990	(2 days)
Barrett Design, Inc.	Jan 1993	(1 day)
Product Genesis, Inc.	Feb 1993	(1 day)
EXOS, Inc.	Jan 1991	1993
Sensible Technologies, Inc.	Jan 1996	Oct 1999
Intuitive Surgical, Inc.	May 1996	Aug 1997
Townsend, Townsend & Crew, LLP	Feb 2001	Sep 2001
Weil, Gotshal & Manges LLP	Oct 2003	May 2004
Strider Labs	Sep 2004	Dec 2005
Novint Inc.	Sep 2004	Nov 2008
Hansen Medical, Inc.	Mar 2006	Feb 2010
Morrison and Forester, LLP	Jan 2009	Sep 2009
Fogarrty LLC	Jun 2009	Jun 2011
Mako Surgical, Inc	Aug 2010	Sept 2011
Pearl, Cohen, Zedek, Latzer, LLP	Mar 2009	Dec 2009
Auris, Inc.	Jan 2009	Dec 2011
U.S. Dept. of Justice	June 2011	June 2017
Perkins Coie, LLP	May 2012	Mar 2013
Davis Wright Tremaine, LLP	Sept 2013	present
Wiley Rein LLP	Jul 2017	Oct 2017
Fish & Richardson	Apr 2018	Sep 2018

6. Government Committees, Service, Etc.

<b>Activity</b>	<b>Beginning</b>	<b>Ending</b>
Editorial Board, <i>Robotics Review</i>	Mar 1987	Dec 1992
Program Committee, NATO Workshop on “Robotics with Redundancy: Design, Sensing and Control”	Jan 1988	Jun 1988
Organizational and Steering Committee, International Symposium on Experimental Robotics	Jun 1989	—
Associate Editor, <i>PRESENCE: Teleoperators and Virtual Environments</i>	Jan 1991	Sep 1995
Editorial Board, <i>PRESENCE: Teleoperators and Virtual Environments</i>	Oct 1995	—
Co-Chairman, 4th International Symposium on Experimental Robotics	May 1993	Jun 1995
Program Committee, 1995 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS '95)	Sep 1994	Aug 1995
Program Committee, International Symposia on Medical Robotics and Computer Assisted Surgery (MRCAS 94-97)	Jan 1994	Feb 1996
Scientific Review Committee, International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)	Feb 1996	Nov 2000
Program Committee, SPIE Conferences on Telerobotics and Telemanipulator Technology. (96,97)	Dec 1995	Nov 1997
Program Committee, International Conference on Advanced Robotics. (96,97)	Aug 1995	Jul 1997
Co-Chair, PHANToM Users Group Workshops (1 through 4)	Aug 1996	1999
Program Committee, ACM Symposium on Interactive 3D Graphics	Jul 1997	Jun 1999
Program Committee, Symposium on Haptic Interfaces Virtual Environment and Teleoperator Systems	Jan 2000	Dec 2003
Organizing Board Member, IEEE ICRA 2000	Jun 1999	Apr 2000
Executive Technical Advisory Council, MICCAI 2000	Jul 1999	Nov 2000
International Program Committee, ICAR	May 2000	Aug 2003
Programme Board, MICCAI 2001	Dec 2000	Nov 2001
Founding Member, IEEE Haptics Technical Committee	2008	
Organizing Committee, ISER 10	2009	2010

6. Government Committees, Service, Etc. (continued)

<b>Activity</b>	<b>Beginning</b>	<b>Ending</b>
Member, NSF Robotics and Human Augmentation Council	Jan 2001	Jun 2002
Prog. Committee (Area Chair), Robotics Science and Systems, MIT June 2005	Sept 2004	June 2005
Steering Committee, NASA/NSF Workshop on Autonomous Mobile Manipulation	Mar 2005	Mar 2005
Program Committee, BioRob 2006, The first IEEE/RAS-EMBS International Conf. on Biomedical Robotics and Bio-Mechatronics Pisa, Tuscany, Italy February 20-22, 2006	Sep 2005	Feb 2006
Member, Board of Directors, Areon Flutes, non-profit organization promoting flute chamber music through education, performance and outreach (www.areonflutes.com)	Feb 2006	present

7. Awards Received

<b>Award</b>	<b>Date</b>
BS degree award “with distinction” from Stanford Univ.	Jun 1975
O. H. Shuck Award for the best paper at the 1981 Joint Automatic Control Conference,	Oct 1981
“Best Paper of Conference,” ASME Design and Production Engineering Technical Conference	Sep 1982
“Best Robotics Thesis of 1983,” awarded by the System Development Foundation.	Sep 1984
“NASA Certificate of Recognition,” issued for development of Multi-Fingered Robotic Hand by Inventions and Contributions Board of NASA.	Apr 1987
Finalist, <i>Discover Magazine</i> Technical Innovation of the Year	1995
Lemelson-MIT Student Prize, Awarded to Advisee, Thomas Massie	1995
Lemelson-MIT Student Prize, Awarded to Advisee, Akhil Madhani	1998
MIT WAM Arm named “Most Advanced Robotic Arm by the Guinness Book of World Records, 2000 Edition”	Jan 2000
Best Paper Award (co-awardee) at World Haptics Conference	Dec 2007
McCarthy Medal for Research Excellence	Nov 2009
IEEE Inaba Technical Award for Innovation Leading to Production for “Contributions to Commercialization of Products in Medical Robotics, Robotics and Haptics”	Feb 2011

## 8. Current Organization Memberships

<b>Organization</b>	<b>Offices Held</b>
BSA, Eagle Scout	awarded 1965
Tau Beta Pi, member	awarded 1974
Institute of Electrical and Electronic Engineers (Life Member)	member since 1976
American Society of Mechanical Engineers, member	since 1977

## 9. Patents and Patents Pending

1. U.S. Patent 4,160,508, "An Improved Controller Arm for a Remotely Related Slave Arm," J. Kenneth Salisbury, Jr. Issued Jul 10, 1979.
2. U.S. Patent 4,635,479, "Force Sensing Apparatus," J. Kenneth Salisbury, Jr. and David L. Brock. Issued Jan 13, 1987.
3. U.S. Patent 4,903,536 "Compact Cable Transmission with Cable Differential," J. Kenneth Salisbury, Jr., et al. Issued Feb 27, 1990.
4. U.S. Patent 4,921,293, "Multi-fingered Robot Hand," Carl Ruoff and J. Kenneth Salisbury, Jr. Issued May 1, 1990.
5. U.S. Patent 5,046,375 "Compact Cable Transmission with Cable Differential," J. Kenneth Salisbury, Jr., et al. Issued Sep 10, 1991.(continuance of 4,903,536)
6. U.S. Patent 5,207,114 "Compact Cable Transmission with Cable Differential," J. Kenneth Salisbury, Jr., et al. Issued May 4, 1993. (continuance of 4,903,536)
7. U. S. Patent 5,327,790 "Torque Sensing Actuator," Mike D. Levin and J. Kenneth Salisbury, Jr. Issued Jul 12, 1994.
8. Foreign patents pending for "Whole-Arm Manipulator," J. Kenneth Salisbury, Jr., et al. Filed Apr 21, 1988.
9. U.S. Patent 5,587,937 "Force Reflecting Haptic Interface," Thomas H. Massie and J.Kenneth Salisbury, Jr. Issued Dec 24, 1996. (continuation of 5,625,576)
10. U.S. Patent 5,625,576 "Force Reflecting Haptic Interface," Thomas H. Massie and J.Kenneth Salisbury, Jr. Issued Apr 29, 1997.
11. U.S. Patent 5,792,135, "Articulated Surgical Instrument for Performing Minimally Invasive Surgery with Enhanced Dexterity and Sensitivity," Madhani, Akhil J. and Salisbury, J. Kenneth. Issued Aug 11, 1998.
12. U.S. Patent 5,797,900, "Wrist Mechanism for Surgical Instrument for Performing Minimally invasive Surgery with Enhanced Dexterity and Sensitivity," Madhani, Akhil J. and Salisbury, J. Kenneth. Issued Aug. 25, 1998.

13. U.S. Patent 5,807,377, "Force-reflecting surgical instrument and positioning mechanism for performing minimally invasive surgery with enhanced dexterity and sensitivity," Madhani, Akhil J. and Salisbury, J. Kenneth. Issued Sept. 15, 1998.
14. U.S. Patent 5,898,599 "Force Reflecting Haptic Interface," Thomas H. Massie and J. Kenneth Salisbury, Jr. Issued Apr. 27, 1999. (continuation of 5,625,576)
15. U.S. Patent 5,976,122 "Articulated Surgical Instrument for Performing Minimally Invasive Surgery with Enhanced Dexterity and Sensitivity," Madhani, Akhil J. and Salisbury, J. Kenneth. Issued Nov. 2, 1999. (continuation of 5,792,135)
16. U.S. Patent 6,111,577, "Method and apparatus for determining forces to be applied to a user through a haptic interface," Zilles, Craig B.; Salisbury, Jr., J. Kenneth; Massie, Thomas H.; Brock, David Lawrence; Srinivasan, Mandayam A.; Morgenbesser, Hugh B., Issued August 29, 2000.
17. U.S. Patent 6,369,834, "Method and apparatus for determining forces to be applied to a user through a haptic interface," Zilles, Craig B; Salisbury, Jr; J Kenneth; Massie, Thomas H; Brock, David Lawrence; Srinivasan, Mandayam A; Morgenbesser, Hugh B. Issued April 9, 2002. Assignee, MIT. Filed June 2, 1999.
18. U.S. Patent 6,371,952, "Articulated surgical instrument for performing minimally invasive surgery with enhanced dexterity and sensitivity," Madhani, Akhil J. and Salisbury, J. Kenneth. Issued April 16, 2002. (Continuation of US Patents 5,976,122 and 5,792,135)
19. U. S. Patent 6,405,158, "Force reflecting haptic interface," Massie, Thomas H and J Kenneth Salisbury, Jr.. Issued June 11, 2002.
20. U.S. Patent 6,459,926, "Repositioning and reorientation of master/slave relationship in minimally invasive telesurgery," William C Nowlin, Gary S Guthart, J Kenneth Salisbury Jr and Gunter D Niemeyer. Issued October 1, 2002.
21. U.S. Patent 6,587,750, "Removable Infinite Roll Master Grip Handle and Touch Sensor for Robotic Surgery," Gerbi, Craig Richard; Duval, Eugene F.; Minami, Don; Hager, Bob; Salisbury, J. Kenneth; Madhani, Akhil; Stern, John; Guthart, Gary S. Filed: September 25, 2001, Issued: July 1, 2003.
22. U.S. Patent 6,522,906 "Devices and Methods for Presenting and Regulating Auxiliary Information on an Image Display of a Telesurgical System to Assist an Operator in Performing a Surgical Procedure," Salisbury, Jr., J. Kenneth; Niemeyer, Gunter D.; Younge, Robert G.; Guthart, Gary S.; Mintz, David S; and Cooper, Thomas G. Issued February 18, 2003.
23. U.S. Patent 6,659,939 "Cooperative Minimally Invasive Telesurgical System," Moll; Frederic H; Rosa, David J; Ramans, Andris D; Blumenkranz, Steven J; Guthart, Gary S; Niemeyer, Gunter D; Nowlin, William C; Salisbury, J. Kenneth; Tierney, Michael. Filed: November 3, 1999, Issued: December 9, 2003
24. U.S. Patent 6,684,129 "Master Having Redundant Degrees of Freedom," Salisbury, Jr., J. Kenneth; Madhani, Akhil J.; Guthart, Gary S.; Niemeyer, Gunter D.; Duval, Eugene F. Filed: April 11, 2002; Issued: January 27, 2004.

25. U.S. Patent 6,714,839 “Master Having Redundant Degrees of Freedom,” Salisbury, Jr., J. Kenneth; Madhani, Akhil J.; Guthart, Gary S.; Niemeyer, Gunter D.; Duval, Eugene F. Filed: September 17, 1999; Issued: March 30, 2004.
26. U.S. Patent 6,786,896 “Robotic Apparatus,” Madhani, Akhil J.; Salisbury, J. Kenneth; Niemeyer, Gunter D. Filed July 17, 2000, PCT Filed September 18, 1998, Issued September 7, 2004.
27. U.S. Patent 6,837,883 “Arm Cart for Telerobotic Surgical System,” Moll; Frederic H.; Rosa; David J.; Ramans; Andris D.; Blumenkranz; Stephen J.; Guthart; Gary S.; Niemeyer; Gunter D.; Nowlin; William C.; Salisbury, Jr.; J. Kenneth; Tierney; Michael J.; Mintz; David S. Filed October 5, 2001, Issued January 4, 2005.
28. U.S. Patent 6,853,965 “Force Reflecting Haptic Interface,” Massie, Thomas H.; and Salisbury, Jr., J. Kenneth. Filed November 16, 2001, Issued February 8, 2005.
29. U.S. Patent 7,370,896 “Robotic Hand With Extendable Palm,” Anderson P, Alcorta JE, DeWinter S, Jensen J, Salisbury JK Jr. and Wegbreit EL. Filed Dec 20, 2004, Issued, May 13, 2008
30. U.S. Patent 7,363,198, “Long Elements Method For Simulation of Deformable Objects,” Bala-niuk; Remis, Costa; Ivan F., Salisbury, Jr.; J. Kenneth. Filing Date: 10/29/2001, Patent Applica-tion 10/016,661, Issued: April 22, 2008.
31. U.S. Patent 7,480,600, “Force Reflecting Haptic Interface,” Massie T, Salisbury JK, Filed Nov 16, 2004; Issued Jan 20, 2009.
32. U.S. Patent 7,865,266, “Cooperative Minimally Invasive Telesurgical System,” Moll FH, Rosa DJ, Ramans AD, Blumenkranz SJ, Guthart GS, Niemeyer GD, Nowlin WC, Salisbury Jr JK, Tierney MJ; Filed April 24, 2003, Issued January 4, 2011
33. U.S. Patent Application No. 12/503,727 “Positioning Apparatus With Lockable Joints And Method Of Use,” Salisbury JK and Savall J, Filed July 31, 2009.
34. U.S. Patent Application No. 12/603,387 “System and Method for Guiding a Medical Instrument with Magnetic Force Control,” Brewer R, Salisbury JK, Loewke KE, and Camarillo DB, October 21, 2009, Priority Date October 21, 2008.
35. U.S. Patent Application No. 12/18,995 “Image Mosaicing Systems and Methods,” Loewke K, Camarillo B, Salisbury JK, and Thrun, Sebastian. Provisional application No. 60/870,147 Filed Dec 15, 2006; PCT Filed Dec 14, 2007.
36. U.S. Patent 8,504,201, “Cooperative Minimally Invasive Telesurgical System.” Issued August 6, 2013.
37. U.S. Patent 8,527,094, “Multi-user Medical Robotic System for Collaboration or Training,” Is-sued Sept. 3, 2013.
38. U.S. Patent 8,632,064, “Positioning Apparatus with Lockable Joints and Method of Use,” Salis-bury K, Savall J, and Blevins, N. Issued January 21, 2014.

39. U.S. Patent 7,806,891, "Repositioning and reorientation of Master/Slave Relationship in Minimally Invasive Telesurgery," Nowlin W, Guthart G, Salisbury K and Niemeyer G. Issued Oct 5, 2010.
  40. U.S. Patent 7,800,609, "Method and Apparatus for Generating and Interfacing with a Haptic Virtual Reality Environment," Tarr C, Salisbury JK, Massie TH and Aviles W. Issued September 21, 2010
  41. U.S. Patent No. 8,715,233. "Assistive Method and Visual-aid Device for Vascular Needle Insertion. Reuben Daniel Brewer & J. Kenneth Salisbury, Jr. Issued May 6, 2014
  42. U.S. Patent 10,271,909, "Display of computer generated image of an out-of-view portion of a medical device adjacent a real-time image of an in-view portion of the medical device," Guthart G, Mintz D, Niemeyer G, Salisbury JK & Younge Robert G. Issued April 30, 2019.
  43. U.S. Patent 10,941,821, "A Four-State Brake Module for Use as a Joint in a Mechanical Linkage," J. Kenneth Salisbury Jr. Peter Gerrit Lowe & Austin D. Epps. Issued March 9, 2021.
10. Professional Registration:

ASME, IEEE

## I. Teaching Experience of J. Kenneth Salisbury, Jr.

<b>Term</b>	<b>Subject Number</b>	<b>Title</b>	<b>Role</b>
FT86	2.70	Introduction to Design	Instructor
FT87	2.70	Introduction to Design	Instructor
FT88	2.70	Introduction to Design	Instructor
Mar 1990		Introduction to Robot Kinematics, Design and Control (one week intensive course as visiting Professor at Scuola Superiore "S. ANNA" Pisa ITALY)	Lectures/Development
IAP90	6.911	"6.270" Robot Design Competition	Sponsor
ST90	2.70	Introduction to Design	Instructor
IAP91	6.911	"6.270" Robot Design Competition	Sponsor
ST91	6.802	Robot Manipulation	Instructor in charge
FT92	2.671	Mechanical Lab	Co-instructor
ST92	2.70	Introduction to Design	Instructor
IAP93	2.971	Machine Shop Practice	Co-instructor
ST93	2.70	Introduction to Design	Instructor
ST94	2.70	Introduction to Design	Instructor
ST02	CS277	Experimental Haptics	Instructor in charge
ST04	CS277	Experimental Haptics	Instructor in charge
ST06	CS277	Experimental Haptics	Instructor in charge
ST08	CS277	Experimental Haptics	Instructor in charge
AT10	CS277	Experimental Haptics	Instructor in charge
AT11	CS277	Experimental Haptics	Instructor in charge
ST12	CS235	Applied Robot Design	Instructor in charge

## II. Publications of J. Kenneth Salisbury, Jr.<sup>1</sup>

### 1. Books

1. Mason, M.T. and J.K. Salisbury, *Robot Hands and the Mechanics of Manipulation*, M.I.T. Press, Cambridge, MA, 1985.
2. Khatib, O. and J.K. Salisbury, (Eds) *Experimental Robotics IV: The 4th International Symposium*, (Lecture Notes in Control and Information Sciences; 233), Springer-Verlag, 1997.
3. Barbagli, Federico; Prattichizzo, Domenico; Salisbury, Kenneth (Eds.), “Multi-point Interaction with Real and Virtual Objects,” Series: “Springer Tracts in Advanced Robotics,” Vol. 18 2005, XIV, 281 p. 142 illus., Hardcover ISBN: 3-540-26036-6.
4. F. Barbagli, D. Prattichizzo, K. Salisbury, “ Multi-contact haptic Interaction with Deformable Objects: a Multi-rate Approach”, chapter in *Robotics Research XI - STAR* (Springer Tracts on Advanced Robotics), Springer-Verlag, 2003.

### 2. Papers in Refereed Journals

1. Salisbury, J.K. and J.J. Craig, “Articulated Hands: Force Control and Kinematic Issues,” *International Journal of Robotics Research*, Vol. 1, No. 1, MIT Press, Cambridge, MA, Spring 1982, pp. 4-17.
2. Salisbury, J.K. and B. Roth, “Kinematic and Force Analysis of Articulated Mechanical Hands,” *ASME Journal of Mechanisms, Transmission and Automation in Design*, Vol. 105, Mar 1983, pp. 35-41.
3. Bejczy, A.K. and J.K. Salisbury, “Controlling Remote Manipulators Through Kinesthetic Coupling,” *ASME Computers in Mechanical Engineering*, Vol. 2, No. 1, Jul 1983, pp. 48-60.
4. Salisbury, J.K., “Issues in Human/Computer Control of Dextrous Remote Hands,” *Transactions on Aerospace and Electronic Systems*, 24:5, Sep 1988, pp. 591-596.
5. Townsend, W.T. and J.K. Salisbury, “The Efficiency Limit of Belt and Cable Drives,” *ASME Journal of Mechanisms, Transmissions, and Automation in Design*, Vol. 110, pp. 303-307, Sep 1988.
6. Bicchi, A, J.K. Salisbury and D.L. Brock, “Contact Sensing from Force Measurements,” *International Journal of Robotics Research*, Vol. 12 No. 3., June, 1993, pp. 249-262. (also MIT AI Lab Memo No. 1262, Oct 1990.)
7. Eberman, B. and Salisbury, J.K., “Application of Change Detection to Dynamic Contact Sensing,” *International Journal of Robotics Research*, Vol. 12, No. 5, October 1994, pp. 369-394.
8. Salisbury, J.K. and Srinivasan, M.A., “Phantom-Based Haptic Interaction with Virtual Objects,” *IEEE Computer Graphics and Applications*, Vol. 17, No. 5, September-October 1997, pp. 6-10.

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<sup>1</sup>Customary practice is that the principal student author is listed first and supervising faculty member listed last.

9. Morrell, J.B. and Salisbury, J.K., "Parallel Coupled Micro-Macro Actuators," *International Journal of Robotics Research*, Vol. 17, No. 7, July 1998, pp. 773-791.
10. Salisbury JK: The heart of microsurgery. *Mechanical Engineering Magazine*, ASME Int'l. 1998 Dec; 120(12): 47-51  
<http://www.memagazine.org/backissues/december98/features/microheart/microheart.html>
11. Salisbury, J.K., "Making Graphics Physically Tangible," *Communications of the ACM*, Vol. 42, No. 8, August 1999, pp. 75-81.
12. Falk, V, McLoughlin J, Guthart G, Salisbury K, Walther T, Gummert J, Mohr F, "Dexterity Enhancement in Endoscopic Surgery by a Computer Controlled Mechanical Wrist," *Min Inv Therapy & Allied Technology*, 1999: 8(4) 235-242.
13. F. Barbagli, R. Devengenzo, K. Salisbury, "Toward Virtual Manipulation: From One Point of Contact to Four", *Sensor Review (special issue on Haptic Devices)*, Vol. 24:1, 2004 pp. 51-59.
14. Salisbury, JK, Conti F and Barbagli, F, "Haptic Rendering: Introductory Concepts," in *Haptic Rendering: Beyond Visual Computing*, Special Issue of *IEEE Computer Graphics and Applications*, March/April 2004, Vol. 24, No. 2, pp. 24-32.
15. Zinn M, Khatib O, Roth B, and Salisbury JK, "New Actuation Approach for Human-friendly Robot Design," *International Journal of Robotics Research*, 23(4/5) 379-398, April-May 2004.
16. Camarillo DB, Krummel TM, Salisbury JK Jr. "Robotic Technology in Surgery: Past, Present, And Future" *Am. J. Surg.* 2004 Oct;188(4A Suppl):2S-15S.
17. F. Barbagli, D. Prattichizzo, K. Salisbury, "A Multirate Approach to Haptic Interaction with Deformable Objects Single and Multipoint Contacts," *Special Issue on the 11th International Symposium on Robotics Research in the International Journal of Robotics Research*, Volume 24, Issue 9, pages 703-716, September 2005.
18. Diolaiti N, Niemeyer G, Barbagli F, and Salisbury JK Jr, "Stability of Haptic Rendering: Discretization, Quantization, Time-Delay and Coulomb Effects", *IEEE Transactions on Robotics and Automation*, Vol.22, Iss.2, April 2006 pp 256-268.
19. H.Z. Tan, F. Barbagli, K. Salisbury, C. Ho, C. Spence "Force-Direction Discrimination is Not Influenced by Reference Force Direction," (Short Paper) *Haptics-e*, The Electronic Journal of Haptics Research ([www.haptics-e.org](http://www.haptics-e.org)), Vol. 4, No. 1, 3-Feb-2006.
20. M. Meehan, D. Morris, C. R. Maurer, A. K. Antony, F. Barbagli, K. Salisbury, S. Girod, "Virtual 3D Planning and Guidance of Mandibular Distraction Osteogenesis," *Computer Aided Surgery*, March 2006; 11(2): 51-62
21. F. Barbagli, K. Salisbury, C. Ho, C. Spence, H. Tan, "Haptic Discrimination of Force Direction and the Influence of Visual Information," *ACM Transactions on Applied Perception*, Vol. 3, No. 2, April 2006, Pages 125-135.
22. D. Morris, C. Sewell, F. Barbagli, N. Blevins, S. Girod, K. Salisbury. "Visuohaptic Simulation of Bone Surgery for Training and Evaluation". *IEEE Computer Graphics and Applications*, Vol. 26, No. 4, p48-57, November 2006.

23. Walker, S.; Loewke, K.; Fischer, M.; Liu, C.; Salisbury, J.K., "An Optical Fiber Proximity Sensor for Haptic Exploration," *Robotics and Automation*, 2007 IEEE International Conference on Robotics and Automation, Volume, Issue, 10-14, April 2007, pp 473-478.
24. D. B. Camarillo, C. F. Milne, C. R. Carlson, M. R. Zinn, and J. K. Salisbury. "Mechanics modeling of tendon-driven continuum manipulators," *IEEE Trans. Robot.*, 24(6):1262-1273, Dec. 2008.
25. D and Salisbury JK. "Automatic Preparation, Calibration, and Simulation of Deformable Objects". *Computer Methods in Biomechanics and Biomedical Engineering* (Taylor & Francis Publishing), Vol 11.4, p263-279, 2008.
26. Sewell C, Morris D, Blevins N, Dutta S, Agrawal S, Barbagli F and Salisbury JK, "Providing Metrics and Performance Feedback in a Surgical Simulator," *Computer Aided Surgery* (2008), 13:2, pgs 63-81.
27. Parikh, Sachin S.; Chan, Sonny; Agrawal, Sumit K.; Hwang, Peter H.; Salisbury, Curt M.; Rafii, Benjamin Y.; Varma, Gaurav; Salisbury, Kenneth J.; Blevins, Nikolas H. "Integration of Patient-Specific Paranasal Sinus Computed Tomographic Data Into a Virtual Surgical Environment," *American Journal of Rhinology & Allergy*, Volume 23, Number 4, July/August 2009 , pp. 442-447(6), OceanSide Publications, Inc.
28. Camarillo DB, Carlson CR, Salisbury JK. "Configuration Tracking for Continuum Manipulators with Coupled Tendon Drive." *IEEE Transactions on Robotics*. In vol. 24, no. 4, pp 798-808. 2009
29. Schlosser J, Salisbury K, and Hristov D "Telerobotic System Concept for Real-Time Soft-Tissue Imaging During Radiotherapy Beam Delivery," *Med. Phys.* 37, 6357 (2010); doi:10.1118/1.3515457 (11 pages).
30. Salisbury, Curt; Gillespie, R.; Tan, Hong Z.; Barbagli, Federico; Salisbury, J. Kenneth, "Psychophysical Detection Thresholds of Sinusoidal Vibrations as a Means for Evaluating Haptic Hardware," Submitted 7/2/2009, RRE: TH-2009-07-0044, *IEEE Transactions on Haptics*.
31. Loewke KE, Camarillo DB, Piyawattanametha W, Mandella MJ, Contag CH, Thrun S, Salisbury JK, "In vivo micro-image mosaicing." *IEEE Trans Biomed Eng.* 2011 Jan;58(1):159-71. doi: 10.1109/TBME.2010.2085082. Epub 2010 Oct 7. <http://www.ncbi.nlm.nih.gov>
32. Salisbury, Curt; Gillespie, R.; Tan, Hong Z.; Barbagli, Federico; Salisbury, J. Kenneth, "What You Can't Feel Won't Hurt You: Evaluating Haptic Hardware Using a Haptic Contrast Sensitivity Function," *IEEE Transactions of Haptics*, April-June 2011 (vol. 4 no. 2) pp. 134-146. <http://doi.ieeecomputersociety.org/10.1109/TOH.2011.5>
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### 3. Proceedings in Refereed Conferences

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#### 4. Other Major Publications

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7. Salisbury J.K., "An Experimental Whole-Arm Manipulator," In Winston, PH and Shellard, SA, eds., *Artificial Intelligence at MIT: Expanding Frontiers*, Vol. 2, MIT Press, 1990, pp. 229-249.
8. Srinivasan, M. and J.K. Salisbury, "Haptic Interfaces," in *Virtual Reality: Scientific and Technical Challenges*, Eds: N. I. Durlach and A. S. Mavor, Report of the Committee on Virtual Reality Research and Development, National Research Council, National Academy Press, 1994, pp. 161-187.
9. Salisbury, JK and Srinivasan, MA (Eds), "Proceedings of the First PHANToM Users Group Workshop," AI Lab Technical Report No. 1596 and RLE Technical Report No. 612, MIT Dec 1996.
10. Salisbury, JK and Srinivasan, MA (Eds), "Proceedings of the Second PHANToM Users Group Workshop," AI Lab Technical Report No. 1617 and RLE Technical Report No. 618, MIT, Dec 1997.
11. Salisbury, JK and Srinivasan, MA (Eds), "Proceedings of the Third PHANToM Users Group Workshop," AI Lab Technical Report No. 1643 and RLE Technical Report No. 624, MIT, December 1998. (<http://dspace.mit.edu/bitstream/handle/1721.1/4135/RLE-TR-624-43814388.pdf>)
12. Salisbury, JK and Srinivasan, MA (Eds), "Proceedings of the Fourth PHANTOM Users Group Workshop," AI Lab Technical Report No. 1675 and RLE Technical Report No. 633, MIT, November 1999.
13. "Medical Miracles for the Next Millennium," LIFE Magazine Special Issue, Fall 1998. Report on Telesurgical System that Salisbury helped develop.

14. Costa I, Balaniuk R, "LEM - An Approach for Real Time Physically Based Soft Tissue Simulation." Proc. ICRA 2001: 2337-2343
15. Lin, M and Salisbury, JK (Eds) *Haptic Rendering: Beyond Visual Computing*, Special Issue of *IEEE Computer Graphics and Applications*, March/April 2004 (Vol. 24, No. 2).
16. Gaw D, Morris D, Salisbury K. "Haptically Annotated Movies: Reaching Out and Touching the Silver Screen," demonstration paper presented at the 14th IEEE Haptics Symposium, March 2006, Washington, DC.
17. Salisbury, Kenneth and Lee, Stephen (Coherent) "Laser Cutting Speeds Robotics Prototyping," Product Design and Development, Nov. 15 2010. <http://www.pddnet.com/editorial-kenneth-salisbury-stephen-lee-laser-cutting-speeds-robotics-prototyping-111510/>
18. Rebecca Day, "Future Tech The 3-D Simulation that Lets Your Surgeon Practice...on You - A new technology lets doctors test out procedures on a simulation of the patient's anatomy," from the November 2009 issue, published online October 28, 2009 <http://discovermagazine.com/2009/nov/28-the-3d-simulation-that-lets-your-surgeon-practice-on-you>

## 5. Internal Memoranda and Progress Reports

1. Starr, G. and J.K. Salisbury, "Remote Manipulator Performance Measures and Display Design," NASA/Ames Research Center Report, Nov 1975.
2. Hill, J.W and J.K. Salisbury, "Study to Design and Develop Remote Manipulator Systems," Stanford Research Institute Report, NAS2-8652, Quaterly Reports 7 & 8, May 1977.
3. MIT Industrial Liaison Office, "Dextrous Robot Hand" (video tape of Salisbury Hand) Jun 1985.
4. Townsend, William and J.K. Salisbury, "Model-X Force-Reflecting Hand Controller," MIT AI Lab, Aug 1987.
5. Salisbury, J.K., J.M. Hollerbach, D.L. Brock and D.M. Siegel, "Analysis and Construction of Contact and Tactile Sensors," Contractor report SAND87-7120, Sandia National Laboratories, Jul 1989.
6. Brock, David L. and J.K. Salisbury, "Force Sensing Fingertip Investigation," Progress Report 1, Sandia Contract No. 23-2299, Jul 20, 1989.
7. Chammas, C.Z. and J.K. Salisbury, "Hands: An Automatic Grasping Approach," NASA, Aug 1989.
8. Melchiorri, C., Salisbury, J.K., "Exploiting the Redundancy of a Hand/Arm Robotic System," A.I. Memo No. 1261, Artificial Intelligence Laboratory, M.I.T., Cambridge, MA, Oct 1990.
9. Brock, David L. and J.K. Salisbury, "Contact Sensing Palm for the Salisbury Hand," Progress Report 2, Sandia Contract No. 75-2608, Jun 11, 1990.
10. Chammas, C.Z. and J.K. Salisbury, "Analysis and Implementation of Robust Grasping Behaviors," NASA/JSC Progress Report, Jun 1990.

11. Melchiorri, C. and J.K. Salisbury, "Exploiting the Redundancy of a Hand-Arm Robotic System," AI Memo No. 1261, Oct 1990.
12. Bicchi, A, J.K. Salisbury and D.L. Brock, "Contact Sensing from Force Measurements," MIT AI Lab Memo No. 1262, Oct 1990.
13. Antonio Bicchi, "Criterion for the Optimal Design of Multiaxis Force Sensors," MIT AI Lab Memo No. 1263, October 1990.
14. Melchiorri C and Salisbury K, "Exploiting the Redundancy of an Hand-Arm Robotic System," AI Memo No. 1261, Artificial Intelligence Laboratory, MIT, Cambridge MA, Oct. 1990.
15. Brian Eberman and David Brock, "Line Kinematics for Whole-Arm Manipulation," AI Memo No. 1255, January 1991.
16. Zanasi, R and J.K. Salisbury, "Dynamic Modeling, Simulation and Parameter Identification for the WAM Arm," MIT AI Lab Memo No. 1387, Sep 1992.
17. Eberman, B.S. and J. Kenneth Salisbury, Jr., "Application of Change Detection to Dynamic Contact Sensing," MIT AI Lab Memo No. 1421, March, 1993.
18. Salisbury, J.K., et al., "Look and Feel: Haptic Interaction for Biomedicine," Progress Report for the period October 1, 1994 through September 30, 1995, ARPA Contract Number DAMD17-94-C-4123, Nov 1995.
19. Salisbury J.K. and M. A. Srinivasan, "Scientific and Technical Report: Development of Haptic Interfaces," Contract: N61339-96-K-0002, CDRL Number: A002 Naval Air Warfare Center Training Systems Division, ORLANDO, FL, Feb 1997.
20. Salisbury, J.K., A. Madhani, C. Tarr, M. Ottensmeyer, D. Green and P. Lee, "Look and Feel: Haptic Interaction for Biomedicine," Progress Report for the period October 1, 1995 through September 30, 1996, ARPA Contract Number DAMD17-94-C-4123, Nov 1996.
21. Salisbury, J.K., A. Madhani, "Look and Feel: Haptic Interaction for Biomedicine," Progress Report for the period October 1, 1996 through September 30, 1997, ARPA Contract Number DAMD17-94-C-4123, Nov 1997.
22. Morris D, Sewell C, Barbagli F, Blevins N, Girod S, Salisbury JK, "Visuohaptic Simulation of Bone Surgery," Stanford University Department of Computer Science Technical Report 2006-13.

## 6. Invited Lectures

Sep 1981, "The Design and Control of a Dexterous Mechanical Hand," 1981 ASME Computer Conference, Minneapolis, MN. (with C. Rouff)

Jan 1982, "A Robot Hand Design and Control Framework," AT&T Bell Labs, Homdell, NJ.

Apr 1982, "Design and Control of a Robot Hand," National Bureau of Standards, Gaithersburg, MD.

Nov 1982. "Dexterous Hand for a Robot," GTE Laboratories, ATL Division, Waltham, MA.

Jul 1983, "Articulated Hand Kinematic and Force Analysis," IBM Europe Institute, Grassau, Germany.

Jul 1983, "The Design of the Stanford/JPL Hand," INRIA, Paris, France.

Sep 1983, "The Design of the Stanford/JPL Hand," University of Massachusetts, Amherst, MA.

Oct 1983, "A Novel Contact Sensing Approach," DARPA Innovation Workshop for Mechanical Innovations in Robotics, Menlo Park, CA.

May 1984, "Robot Hand Control," General Motors Research Labs, Warren, MI.

Jun 1984, invited discussant, Ro.Man.Sy 1984, Udine, Italy.

Jun 1984, "Articulated Hand Design and Control," CNRS/LAAS Toulouse, France.

Jul 1984, "Articulated Hand Design and Control" Electrotechnical Labs, Tsukuba, Japan.

Oct 1984, "Force and Position Control of a Robot Hand," Carnegie-Mellon University, Robotics Institute, Pittsburgh, PA.

Dec 1984, "Robot Hand Kinematic Analysis," Robotics Seminar, Harvard University, Cambridge, MA.

Apr 1985. segment in "Miraculous Machines," National Geographic Special. (Issued as video tape entitled "Miniature Miracle: The Computer Chip," National Geographic Society, 1985.)

May 1985, "An Experimentation Environment for Robot Hand Manipulation," Robotics Seminar, Stanford University, Stanford, CA.

May 1985, "An Experimentation Environment for Robot Hand Manipulation," Science Center, Rockwell International, Thousand Oaks, CA.

May 1985, "An Experimentation Environment for Robot Hand Manipulation," Mechanical Engineering Dept., Ohio State University, Columbus, OH.

Jul, 1985, "Design, Sensor, and Control Issues for Grasping and Manipulation with a Robot Hand," Engineering Foundation Conference, Biomechanics & Neural Control of Movement: Sensor Based Movement, Henniker, NH.

Sep, 1985, "Hand Grip Design for a Force Reflecting Master," NASA/JPL, Pasadena CA.

Oct 1985, "Potentials for Dextrous Remote Manipulation," CEA (French Atomic Energy Agency) - Teleoperator Division, Paris, France.

Nov 1985, Segment in "Taking the Biscuit," BBC TV Robotics Special, London, UK.

May 1986. Segment in "Nerves of Steel," BBC Radio Interview, London, UK.

Oct 1986, "Autonomous and Human Controlled Robot Hands," MIT Sea Grant Program Symposium on Undersea Manipulation, Cambridge, MA.

Sep 1986, invited discussant Ro.Man.Sy 1986, Cracow, Poland.

Nov 1986, "New Design Ideas for the JPL Force Reflecting Hand Controller," NASA/Jet Propulsion Labs, Pasadena, CA.

Dec 1986, "Force Reflecting Articulated Hand Masters," NASA/Jet Propulsion Labs, Pasadena, CA.

Feb 1987. Segment on Salisbury Hand, Discover Science TV Program.

Feb 1987, "Integration of Touch Sensing with Articulated Hands," Sandia National Labs, Albuquerque NM.

Feb 1987, "Analytical and Experimental Techniques for Articulated Hand Design," Distinguished Lecturer Series, Department of Mechanical Engineering, University of Wisconsin, Madison, WI.

Mar 1987. Film of Salisbury Hand at Boston Museum of Science, Boston, MA.

May 1987, "Integration of Hand and Arm Control for Space Applications," Grumman Aerospace, Bethpage, New York.

Jun 1987-present. Film of Salisbury Hand at Boston Computer Museum, Boston, MA.

Sep 1987, "Whole Arm Manipulation," ONR Workshop on Haptics & Sensory Guided Motor Control, Falmouth, Cape Cod.

Oct 1987, "Design for Force Control," MIT Mechanical Engineering Department Seminar on Force Control, Cambridge, MA.

Oct 1987, "Design Proposal for Dextrous Underwater Manipulator," DARPA, Washington, D.C.

Feb 1988, "System Design of WHOI/MIT Whole Arm Manipulator," DARPA, Washington, D.C.

Mar 1988, "Control Architecture for Implementing Hand Reflex Control," NASA/Johnson Space Center, Houston, TX.

Apr 1988, "Teleoperator Hand Calibration," Arthur D. Little Corp., Cambridge, MA.

Apr 1988, Tutorial: "Manipulation of Multiple Fingers," IEEE International Symposium on Robotics and Automation, Philadelphia, PA.

May 1988, "Overview of Hand Control," Odetics Corp., Anaheim, CA.

May 1988, "Flight Qualification Issues for the JPL Force Reflecting Hand Controller," NASA/JPL, Pasadena, CA.

May 1988, "MIT WAM Arm," Stanford University Mechanical Engineering Department, Stanford, CA.

May 1988, "Remote Robot Hand and Arm Challenges," Workshop on Robotics Needs for the Exploration of the Moon and Mars," NASA/Ames Research Center, Moffett Field, CA.

Oct 1988, "Overview of Hand and Arm Research at MIT's AI Lab," SME-MIT Robotics Conference, Cambridge, MA.

Dec 1988. Interview in "Why Can't a Robot Be More Like a Man?" New York Times.

Jan 1989, "Interaction between Dexterity and AI," Invited Panel Member, NASA/JPL Conference on Space Telerobotics, Pasadena, CA.

Jan 1989, "Fundamentals of Dextrous Manipulation," International Ocean Technology Congress, Honolulu, HI.

Oct 1989, "Whole Arm Manipulation: Mechanics and Control," California Institute of Technology, Mechanical Engineering Department, Pasadena, CA.

Jul 1990, "How Not To Make A Bad Situation Worse," DOE/Industry/University/Lab Forum on Robotics for Environmental Restoration, Waste Managements and Waste Minimization, Albuquerque, New Mexico.

Aug 1990, "Overview of Hand and Arm Research at MIT" NASA/Ames Research Center, Mtn. View, CA.

Nov 1990, "Robotics Research at MIT's AI Lab.," IBM Academy of Technology, Annual Meeting, Cambridge, MA. Invited presenter/discussant.

Nov 1990, "Automatic Grasping and Whole Arm Manipulation," Columbia University, New York, New York. Also to be presented at the University of Massachusetts, Amherst MA., Nov 1990.

Nov 1990, "Whole-Arm Manipulation and Sensing," NSF/DARPA Workshop on Identification of Specifications for a Mobile Platform with Material Handling Capabilities, University of Pennsylvania, Philadelphia, PA.

Apr 1991, "Whole-Arm Control and Utilization in Hazardous Environments," Invited panel member in workshop on "The Application of Robotics to the Handling of Hazardous Wastes, Materials, and Equipment," at the 1991 IEEE International Conference on Robotics and Automation, Sacramento CA.

Oct 1991, co-chair and speaker at MIT Industrial Liaison Program Telerobotics Symposium, Cambridge, MA.

Jan 1992, "Automatic Grasping and Whole Arm Manipulation," Carnegie-Mellon Robotics Institute, Pittsburgh, PA.

Sep 1992, "Automatic Grasping and Whole Arm Manipulation," Keynote Speaker, IMACS/SPIE Conference, Kobe, Japan.

Oct 1992 "Automatic Grasping and Whole Arm Manipulation," Keynote Speaker, 23rd ISIR Barcelona Spain.

Nov 1992, "Haptic Interfaces," invited talk at the Annual Meeting of the American Acoustical Society, New Orleans, LA.

Oct 1993, "3 Grasps," Video Presentation at the 6th International Symposium on Robotics Research (ISRR), Oct. 2-5 1993, Hidden Valley, Pennsylvania

Feb 1993, "Haptics," Invited presentation at meeting of the National Academy of Sciences Special Committee on Virtual Reality, Washington DC.

Feb 1994, "Toward Dexterous Manipulation for Hazardous Environments," invited lectures, Korean Atomic Energy Research Institute (KAERI), Taejon, N. Korea.

May 1994, "The PHANToM Haptic Interface," invited presentation at AAAI Spring Symposium Series, Toward Physical Interaction and Manipulation, Stanford, CA.

Jan 1995, "Progress in Haptic Simulation," Invited Participant, ARPA Workshop on Telemedicine, Medicine Meets VR, San Diego.

Jan 1995, "Grasp Assessment and Automatic Grasping - Haptic Challenges," Invited presentation, NASA/JPL, Pasadena CA.

Mar 1995, "Whither Force Feedback?," Invited Panelist, IEEE-VRAIS '95, Research Triangle Park, NC.

Apr 1995, "Haptic Rendering" Invited presentation, ACM Symposium on Interactive 3D Graphics, Monterey, CA.

Jan 1996 "Feeling Compliant Materials," Invited Participant, ARPA Workshop on Haptics, Medicine Meets VR, San Diego, CA.

Apr 1996, "The Basics of Haptic Interfaces and Rendering Techniques," invited presentation, MIT ILP Symposium on Telemedicine, Cambridge, MA.

Jan 1996 "Look and Feel: Haptic Simulation and Telesurgical Systems," Invited Participant, ARPA Workshop on Haptics, Medicine Meets VR, San Diego, CA.

Apr 1996, "Review of Robotic Force Control Mechanisms and Techniques," invited seminar, Intuitive Surgical Corp, Palo Alto, CA.

Apr, 1997 "Haptic Rendering of Implicit Surfaces," invited live demonstration, ACM Symposium on Interactive 3D Graphics, Providence RI.

Jun 1997 "From Force Control to Force Display, " Invited Plenary Session, 5th International Symposium on Experimental Robotics, Barcelona Spain, June 1997.

Jun 1997 "Dexterous Systems" Invited tutorial, Workshop on Autonomous Robotic Systems, Institute of Systems and Robotics, University of Coimbra, Portugal.

Oct 1997 "Haptic Geology" Seminar at NASA JPL, Pasadena CA.

May 1998 "Touching and Being Touched: Robot Hands, Arms and Haptic Interfaces," Intelligent Mechanisms Seminar, NASA/Ames Research Center, Moffet Field, CA

May 1998 "Touching and Being Touched: Robot Hands, Arms and Haptic Interfaces," Stanford AI-Vision-Robotics Colloquium, Stanford, CA

March 1999 "Surgical Robotics," invited presentation, Commonwealth Medical Officers Meeting, Sydney Australia.

March 1999 "Touching and Being Touched: Robot Hands, Arms and Haptic Interfaces," Research

Colloquium, Australian National University, Dept. of Systems Engineering, Canberra, Australia

September 1999 “Telerobotic Surgery,” Invited Lecture, Society for Minimally Invasive Therapy, Westin Copley Place, Boston

October 1999 “What is VR?” Invited Lecture, American College of Surgeons Annual Meeting, San Francisco, CA

November 1999 “Haptics and Telesurgery,” Invited Lecture, Stanford Medical Device Seminar: Leaders and Visionaries, Stanford, CA

March 2000 “Haptics and Telesurgery,” Invited Lecture, Stanford Computer Forum Annual Meeting, Stanford, CA

April 2000 “Hands On: Haptics and Telesurgery,” Keynote Lecture, IEEE Int. Conference on Robotics and Automation, San Francisco, CA.

June 2000 “Surgical Robotics,” Invited Lecture, CARS2000 Conference, San Francisco CA.

Oct 2000 “Telerobotically Enhanced Surgical Dexterity,” Keynote Lecture, MICCAI 2000, Pittsburgh PA.

Oct 2000 “Tele-robotically Enhanced Surgical Dexterity,” Invited Panel Presentation, Panel on Mechanically Assisted Surgery in the Operating Room: Present Status and Future Predictions of Surgical Robotics, American College of Surgeons 86th Annual Clinical Congress, Chicago IL.

Feb 2001 “Haptics and Telesurgery ... Sanding Wood,” Invited presentation at TED 11 (Technology, Education and Design), Monterey CA.

November 2001 “Robotic Surgery, Past, Present, and Future,” Invited Panelist at the Annual Meeting of the Japan Society of Computer Aided Surgery, Kyushu, Japan

July 2002 “Surgical Robotics,” Invited Panelist, Expert Panel on the Future of Robotics in Healthcare Delivery, Health Technology Center, San Francisco, CA

January 2004 “Frontiers in Haptics and Robotically Enhanced Surgery,” Invited speaker at the Annual Stanford Hoover House Circle Dinner (Stanford’s Major Donors group), Stanford, CA

March 2005 “Embodiment of Mobile Manipulation Systems,” Invited Speaker at NASA/NSF Workshop on Autonomous Mobile Manipulation, Houston TX.

March 2006 “The Path to Practical Robotics,” Invited Speaker at Stanford MediaX 4th Annual Conference “People, Technology & Innovation.”

August 2008 “Personal Robotics,” Invited presentation at Google Sci-Camp-Foo 2008 Symposium

July 2007 “BioRobotics,” Invited lecture at Stanford’s Annual E-day

#### IV. Theses Supervised by J. Kenneth Salisbury, Jr.

##### S.B. Theses

Brock, David L., "Strain Gage Based Force and Tactile Sensors," Jun 1984.

Oberoi, Pankaj, "I/O Control Optimization on the MIT-WAM," May 1991. (EECS)

Saito Steven R., "Characterization Contact Events," May 1991. (EECS)

Tom, Alfred C., "Study of Sensor-Mediated Velocity-Based Robotic Grasping Behaviors in a Two-Finger Four-Joint Hand," Jun 1991.

Everett, Derek L., "Development and Analysis of a Robotic Sensor Interface," May 1992. (EECS)

Massie, Thomas H. "Design of a Three Degree of Freedom Force-Reflecting Haptic Interface," SB thesis, MIT EECS Department, May 1993.

Page, James, "The MIT Wrist/Hand: Mounting and Finger Redesign," May 1993.

Swarup, Nitish, "Design and Control of a Two-Axis Gimbal System for Use in Active Vision," May, 1993.

Hoeg, Hans D., "Development of Virtual Objects of Arbitrary Shape," May 1994.

Kim, Euree Y. "An Example of 3-D Object Localization and Connectivity in Object-Grasping Applications," May 1996.

Sallum, Hani M., "Design of the Rocky 7 Modular End-Effector," May 1996.

Goodwin, W. Alexander, "Minimalistic Force-Feedback Device: Reducing Cost of Haptic Interfaces," June 1997.

Brave, Scott B., "Tangible Interfaces for Remote Communication and Collaboration," June 1998. (School of Architecture)

Tarr, Christopher M., "Rigid, Plastic, and Visco-Elastic Surface Interaction," Feb 1998. (EECS - Advanced Undergraduate Project)

##### S.M. Theses

Gehlbach, Garth E. "The Design and Implementation of a Multipurpose End Effector," Jan 1985. (also used for S.B. Degree)

Chiu, Stephen L., "Generating Compliant Motion of Objects with an Articulated Hand," Jun 1985.

Abramowitz, Jeff, "Design and Control of a Redundant Mechanism for Small Endpoint Motion," Aug 1985 (EECS).

Brock, David, "Enhancing the Dexterity of a Robot Hand Using Controlled Slip," May 1987.

Paul, Benjamin J., "A Systems Approach to the Torque Control of a Permanent Magnet Brushless Motor," Aug 1987.

Tabor, Keith A., "The Real-Time Digital Control of a Regenerative Above-Knee Prosthesis," May 1988 (Dual Degree - S.M. in Mechanical and Electrical Engineering). (co-supervised with Prof. Flowers, Mechanical Engineering Department).

DiPietro, David M., "Development of an Actively Compliant Underwater Manipulator," May 1988 (MIT/Woods Hole Joint Program, Department of Oceanography and Oceanographic Engineering). (co-supervised with Dr. Yoerger, WHOI.)

Eberman, Brian S., "Whole-Arm Manipulation: Kinematics and Control," Jan 1989.

Greiner, Helen, "Passive and Active Grasping with a Prehensile Robot End-Effector," May 1990 (EECS at MIT). AI-TR 1235.

Levin, Michael D., "Design and Control of a Closed Loop Torque Actuator," May 1990. AI-TR 1244.

Fullam, Scott F., "CONAN: A Four Degree of Freedom Arm for Use on a Mobile Platform," May 1990 (EECS, also used for S.B. Degree in EECS).

Chammas, Camille Z., "Analysis and Implementation of Robust Grasping Behaviors," Jun 1990. AI-TR 1237.

Hove, Barbara M., "A Study of 3-D Robotic Catching," Jun 1991. (Co-supervisor with Prof. Slotine, ME Dept.)

Moyer, Thomas H. "The Design of an Integrated Hand and Wrist Mechanism," Feb, 1992.

Anderson, Catherine, "The Design of a Compact Actuator System for a Robotic Wrist/Hand," Feb, 1992.

Zilles, Craig, "Haptic Rendering with the Tool-Handle Haptic Interface," May 1995.

Swarup, Nitish, "Haptic Interaction with Deformable Objects Using Real-Time Dynamic Simulation," Sep 1995.

Massie, Thomas H., "Initial Haptic Explorations with the Phantom: Virtual Touch Through Point Interaction," Feb 1996.

Cadapan, Loreli "Autonomous Rock Acquisition for a Microrover to be Used in Planetary Exploration," Feb 1997. (EECS)

Koontz, Bryan S., "A Multiple Vehicle Mission Planner to Clear Unexploded Ordnance From A Network of Roadways," June 1997. Also available as Draper Laboratory Technical Report CSDL-T-1285.

Liu, Trudy "Embedding Interactive Haptive Objects in HTML," May 1997. (EECS, also fulfilled SB degree)

Latimer, Craig, "Haptic Interaction with Virtual Rigid Objects Using Real-Time Dynamic Simulation," Aug 1997.

Shah, Vinay, "Design and Control of a Nonlinearly Compliant Robotic Finger," Aug, 1997.

Theobald, Daniel A., "Arbitrated Robot Control on the Web, System Design and Implementation," Dec, 1997.

Anthony, Brian W., "Anisotropic Wave Guides - Propagation, Focusing and Dispersive Phenomena with Applications for Non-Destructive Testing," Jan 1998.

Green, Donald F., "Haptic Simulation of Naturally Occuring Textures and Soil Properties," June 1998.

Ben-Ur, Ella, "Development of a Force-Feedback Laparoscopic Surgery Simulator," Sept 1999.

Katz, Arrin "The Design and Application of a Nonlinear Series Compliance Actuator for Use in Robotic Arms," Sept 1999.

Curtis, Andrew W. "A Nonlinearly Compliant Transmission Element for Force Sensing and Control," January, 2000.

### **Engineer's Theses**

N/A

### **Doctoral Theses, Supervisor**

Townsend, William T., "The Effect of Transmission Design on Force-Controlled Manipulator Performance," Apr 1988. AI-TR 1054.

Brock, David L., "A Sensor Based Strategy for Automatic Robotic Grasping," Jan 1993.

Eberman, Brian S., "Contact Sensing: A Sequential Decision Approach to Sensing Manipulation Contact Features," Feb, 1995. AI-TR 1534.

Morrell, John B., "Parallel Coupled Micro-Macro Actuators," Jan 1996. AI-TR 1563.

Leveroni, Susanna R., "Grasp Gaits for Planar Object Manipulation," Feb 1997.

Madhani, Akhil J. "Design of Teleoperated Surgical Instruments for Minimally Invasive Surgery," Sept 1997.

Ottensmeyer, Mark, "Minimally Invasive Instrument for *in vivo* Measurement of Solid Organ Mechanical Impedance," Jan 2001.

Hong, Jesse "Modeling, Estimation, and Control of Robot-Soil Interactions," June 2001.

F. Barbagli, "A Multi-Point of Contact Framework for Haptic Interaction", PhD dissertation, July 2002, Scuola Superiore S. Anna, Pisa, Italy. (co-advised with M. Bergamasco (Scuola Superiore S. Anna) and P. Dario (Univ. of Pisa) )

N. Diolaiti, "Robotic Interaction: Analysis and Control", PhD dissertation, PhD dissertation, May 2005, University of Bologna (co-advised with C. Melchiorri (Univ. of Bologna) and G. Niemeyer (Stanford) )

Morris Dan, "Haptics and Physical Simulation for Virtual Bone Surgery," PhD Thesis, Computer Science, August 2006.

Sewell, Christopher, "Automatic Performance Evaluation in Surgical Simulation," Spring 2007.

Walker, Sean, "Robot Haptics: Object Recognition Through Dynamic Exploration," Winter 2009.

Camarillo, David, "Mechanics and Control of Tendon Driven Continuum Manipulators," Spring 2008.

Loewke, Kevin E., "Image Sequence Analysis for Dynamic and Time-Lapse Microscopy," PhD Mech Engr, Stanford, August 2009.

Salisbury, Curt, "Haptic Hardware: Evaluation, Design and Placement" PhD Mech Engr, Stanford, September 1009.

Berger, Eric, "Unified Architecture for Mobile Manipulation and Highly Capable Robotics" Expected Spring 2010.

Wyrobek, Keenan, "Design and Evaluation of Bi-Manual Robotic Systems for Human Environments: VisioHaptic Interfaces & Mobile Manipulation," Expected Spring 2010.

Schlosser, Jeffery, "Robotic Ultrasound Image Guidance for Radiation Therapy," PhD Mechanical Engineering, Stanford, June 2013.

Walker, Daniel S, "Design of Versatile Telerobotic Systems Using Variable Impedance Actuation and Control," PhD Mechanical Engineering, Stanford, June 2013.

Leeper, Adam, "Robot Telemanipulation in Unstructured Environments: Sensors, Algorithms, Interfaces," PhD Mechanical Engineering, Stanford, June 2013.

Wilson, Rob "Control for High Frequency Rendering on Impedance Type Haptic Devices," PhD Mech Engr, March 2014.

Chan, Sonny, " Haptic Rendering of Medical Image Data for Surgical Rehearsal," PhD Comp Sci, Stanford, March 2014.

Brewer, Reuben, "Haemobot: Requirements and Design," PhD Mech. Engr. August 2014

Stauber, Mark, "Laposcopic Trainer," PhD Mech. Engr., August 2015

### **Doctoral Theses, Reader**

West, Harry, "Kinematic Analysis for the Design and Control of Braced Manipulators," Jun 1986.

An, Chae H. "Trajectory and Force Control of A Direct Drive Arm," Sep 1986. (EECS) MIT AI-TR-912.

Das, Hari, "Kinematic Control and Visual Display of Redundant Teleoperators," Apr 1989.

Buzan, Forrest T., "Control of Telemanipulators with Time Delay: a Predictive Operator Aid with Force Feedback," May 1989.

Li, Weiping, "Adaptive Control of Robot Motion," Apr 1990. (Aeronautics and Astronautics Department)

Chang, Pyung H., "Analysis and Control of Robot Manipulators with Kinematic Redundancy," May 1987. MIT AI-TR 1021.

Eppinger, Steven D. "Modeling of Robot Dynamic Performance for Endpoint Force Control," Sep 1988. MIT AI-TR 1072.

Schempf, Hagen, "Comparative Design, Modeling and Control Analysis of Robotic Transmissions," Aug 1990. (MIT/WHOI Joint Program in Oceanography and Oceanographic Engineering). WHOI-

90-43.

Vaaler, Erik G., "Automated Assembly in the Presence of Significant System Errors," Dec 1990.

Siegel, David M., "Pose Determination of a Grasped Object Using Limited Sensing," May 1991. (Department of Electrical Engineering and Computer Science). MIT AI-TR 1300.

Chin, Kan-Ping, "Stable Teleoperation with Optimal Performance," Mar 1991.

Sturman, David J., "Whole-Hand Input," Dec 1991. (Department of Architecture).

McCarragher, Brenan J. "A Discrete Event Dynamic Systems Approach to Robotic Assembly Tasks," Jul 1992.

Yang, Hyun S., "Sub-time-optimal Control for Point-to-point Operations of Robot Manipulators," Sep 1992.

Liu, Sheng, "Task-Level Robot Adaptive Control Based on Human Teaching Data and Its Application to Deburring," Dec 1992.

Caine, Michael E. "The Design of Shape from Motion Constraints," Dec 1992.

Yang, Boo-Ho, "Progressive Learning and its Application to Robotic Control," Jan 1994.

Kang, Sing-Bing, "Robot Instruction by Human Demonstration," Nov 1994. (Robotics Institute, Carnegie-Mellon University).

Niemeyer, Gunter D., "Using Wave Variables in Time Delayed Force Reflecting Teleoperation," Sept 1996. (Department of Aeronautics and Astronautics)

Son, Jae S., "Integration of Tactile Sensing and Robot Hand Control," May 1996. (Division of Applied Sciences, Harvard University)

Voyles, Richard, "Toward Gesture-Based Programming: Agent-Based Haptic Skill Acquisition and Interpretation," Aug 1997. (Robotics Program, Computer Science Dept, Carnegie Mellon University)

Schloerb, David, "Adaptation of Perceived Depth Related to Changes of the Effective Interpupillary Distance in Computer-Graphic Stereoscopic Displays," May 1997.

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