

Peter Kazanzides

PERSONAL DATA

Birth date August 14, 1961
Birth place Jersey City, New Jersey
Citizenship USA
Family Married, two children

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EDUCATION

- Ph.D. Electrical Engineering – Brown University, May 1988
Thesis: Design and construction of a real-time multiprocessor system (SIERA), which was applied to two different robots. Development and implementation of a compliant control strategy which enables a robot to interact with an imprecisely known environment.
- Sc.M. Applied Mathematics – Brown University, May 1987
- Sc.M. Electrical Engineering – Brown University, May 1985
Thesis: Modeling of a hydraulic actuator and design of digital control laws. Analyzed the effects of non-linearities in the model and the control laws and presented experimental results to verify the theory.
- Sc.B. Electrical Engineering (Honors, Magna Cum Laude) – Brown University, May 1983
- A.B. Computer Science – Brown University, May 1983

RESEARCH SUMMARY

My research activities are in computer-assisted surgery and space telerobotics, which share the common themes of human/machine interfaces to keep the human in the loop, real-time sensing to account for uncertainty, and system engineering to enable deployment in the real world. Surgical robotics requires a partnership between man and machine that must operate in an unstructured environment with constraints on visibility, accessibility, and sterility. My research has focused on the integration of information from various sources, such as preoperative and intraoperative imaging and force sensing, to address these challenges. I have also applied these techniques to space robots; specifically, for a telerobotic system for satellite servicing, which is subject to time delays of 2-7 seconds.

In 1989, while developing a robot for orthopaedic surgery, I pioneered the use of force-controlled guidance as a surgical robot interface. More recently, I have been applying virtual fixtures as guidance and safety constraints and have performed research in augmented reality interfaces for both medical and space applications. My current research interests include the integration of real-time sensor feedback, including model-based and data-driven (machine learning) approaches, to enable

robotic assistance in more challenging environments. I am also exploring the use of sensor fusion, incorporating different tracking technologies such as electromagnetic, optical, and inertial, to improve the robustness of tracking technology for applications in robotics, surgical navigation, and augmented reality.

These applications have also motivated me to define and develop enabling systems and architectures. A surgical robot, with associated information sources, generally requires concurrent processing, with low-latency exchange of information. My research involves the application of component-based software engineering concepts to provide a uniform programming model that spans from multi-threaded systems to multi-process and multi-processor systems. This research is embodied in the open-source cisst libraries and Surgical Assistant Workstation (SAW) software. As a service to the research community, I have disseminated the hardware and software to control research da Vinci Systems at more than forty institutions worldwide, with additional sites in process.

WORK HISTORY

Research Professor, Dept. of Computer Science July 2014 – present
Associate Research Professor, Dept. of Computer Science Sept. 2008 – June 2014
Assistant Research Professor, Dept. of Computer Science Dec. 2002 – Sept. 2008

Chief Systems and Robotics Engineer, Center for Computer-Integrated Surgical Systems and Technology, Johns Hopkins Univ., Baltimore, MD

Leading development of open source CISST/SAW software package, custom hardware, and open source da Vinci Research Kit (dVRK). Managing several projects, including development of robot systems for neurosurgery, prostate brachytherapy, orthopaedics, and satellite servicing and research in augmented reality head-mounted displays.

Co-founder and Director of Robotics and Software, Integrated Surgical Systems, Davis, CA Nov. 1990 – June 2002

Formed ISS to develop and commercialize the ROBODOC® Surgical Assistant for human use. Designed and implemented the electronics and software, achieving major improvements in the user interface, safety systems, accuracy, maintainability and cost. Worked with robot manufacturer to customize industrial robot for medical use. Assisted with development of engineering processes appropriate for a medical device manufacturer, including production of standard operating procedures, written specifications, formal design reviews, manufacturing procedures, and configuration management and change control. Participated in ISO9001 certification and CE marking, including EMC certification for emissions and immunity. Obtained 510(K) clearance from FDA for ORTHODOC planning system. Program Manager for \$4 million NIST ATP joint venture (ISS, IBM and Johns Hopkins Univ.) investigating the application of robotics to total hip revision surgery. Assisted with the acquisition of IMMI in Lyon, France to increase technology portfolio and enter neurosurgery business. Extensive experience in field service and customer support including installation of systems at clinical trial sites, training of personnel, support during surgical procedures, and system maintenance. Managed inter-disciplinary group of 3-7 engineers.

Visiting Associate Research Engineer, University Of California, Davis, CA Mar. 1990 – Nov. 1990

Continued work on hip replacement robot that was started as joint project between IBM and UC Davis. Brought robot into veterinary operating room, where it was used for 26 canine surgeries, all successful. Refined system based on clinical feedback.

Post-Doctoral Researcher, IBM T.J. Watson Research Center, Yorktown Heights, NY

Mar. 1989 – Mar. 1990

Performed research on medical applications of robotics. Developed compliant control strategies and robot software for total hip replacement surgery. Integrated force sensor, pitch axis, and signal processor with IBM robot.

PROFESSIONAL ACTIVITIES

Editorial Boards

Editorial Board, International Journal of Medical Robotics and Computer Assisted Surgery, Wiley, 2019

Associate Editor, IEEE International Conference on Robotics and Automation (ICRA), 2011-2018

Associate Editor, IEEE International Conference on Intelligent Robots and Systems (IROS), 2011

Conference and Workshop Committees

Co-organizer of Tutorials on Medical Robotics at MICCAI 2005, MICCAI 2006, and ICRA 2007.

Co-organizer of Workshop on Medical Robotics at MICCAI 2006, Copenhagen, Denmark, Oct 5, 2006

Working Group member, High Confidence Medical Device Software and Systems workshop, Philadelphia, PA, June, 2005

Program Committee, 1st Intl. Conf. on Complex Medical Engineering (CME) 2005, Takamatsu, Japan

Program Committee, 2nd Intl. Conf. on Complex Medical Engineering (CME) 2007, Beijing, China

Program Committee, Medical Image Computing and Computer Assisted Interventions (MICCAI) 2008, New York, NY

Co-organizer of Workshop on Systems and Architectures for Computer Assisted Interventions at MICCAI 2008-2013

Area Chair, 1st Intl. Conf. on Information Processing in Computer-Assisted Interventions (IPCAI) 2010, Geneva, Switzerland

Breakout Session Lead, Medical Robotics, NSF 2014 National Workshop on Research Frontiers in Medical Cyber-Physical Systems, Feb. 2014.

Co-organizer of Workshop on Community Consensus Benchmarks for Clinical Translation of Medical Robots at IROS 2014, Chicago, IL, Sept. 2014

Co-organizer of Workshop on Shared Frameworks for Medical Robotics Research at ICRA 2015, Seattle, WA, May 2015

Organizer of Workshop on Shared Platforms for Medical Robotics Research at IROS 2017, Vancouver, Canada, Sept. 2017.

Co-organizer of Workshop on Supervised Autonomy in Surgical Robotics at ICRA 2018, Brisbane, Australia, May 2018.

Organizer of Tutorial on Collaborative Robotics Toolkit (CRTK) and Open Platforms for Medical Robotics Research at IROS 2018, Madrid, Spain, Oct. 2018.

Organizer of Workshop on Data-Driven Methods for Robotic Minimally-Invasive Surgery at International Symposium on Medical Robotics (ISMR), Atlanta, Georgia, Apr. 2019.

Organizer of Workshop on Open Platforms for Medical Robotics Research at International Symposium on Medical Robotics (ISMR), Atlanta, Georgia, Nov. 2021.

Organizer of Raven/dVRK Surgical Robotics Research Symposium, Online, March 2021, July 2021.

Program Committee of Hamlyn Symposium, London, UK, June 2017-2022

Program Committee, IEEE International Conference on Robotic Computing, 2017-2022

Other Committees

ASTM working group F04.05 developing standards for Computer Assisted Orthopaedic Surgery (CAOS) Systems, 2004-2010

Engineering Faculty Academic Advisory Committee (EFAAC), Johns Hopkins University, Whiting School of Engineering, (aka WSE Faculty Senate), elected 2021.

HONORS AND AWARDS

- Computerworld/Smithsonian Award in Medicine – awarded to ISS, Inc., June 1992
- IBM Graduate Predoctoral Fellowship – Brown University, academic years 1985 - 1988
- Thomas Carpenter Premium Award, recognizing top student in graduating class – Brown Univ., May 1983
- Magna Cum Laude and Honors in Engineering – Brown University, May 1983

ACADEMIC ADVISING

Ph.D. Theses Advised

Mohammad Matinfar, *Precise Irradiation and Delivery of Complex Dose Volumes for Small Animal Research*, Computer Science, The Johns Hopkins University, January 2011.

Tian Xia, *Model Driven Robotic Assistance for Human-Robot Collaboration*, Computer Science, The Johns Hopkins University, October 2013.

Min Yang Jung, *State-based Safety of Component-based Medical and Surgical Robot Systems*, Computer Science, The Johns Hopkins University, May 2015.

Hasan Tutkun Sen, *Robotic System and Co-manipulation Strategy for Ultrasound Guided Radiotherapy*, Computer Science, The Johns Hopkins University, April 2016.

Zihan Chen, *A Scalable, High-Performance, Real-Time Control Architecture with Application to Semi-Autonomous Teleoperation*, The Johns Hopkins University, October 2017.

Bongjoon (Nathan) Cho, *Forward and Inverse Treatment Planning Solutions for Small Animal Radiation Research*, The Johns Hopkins University, October 2017.

Long Qian, *Augmented Reality Assistance for Surgical Interventions using Optical See-Through Head-Mounted Displays*, The Johns Hopkins University, April 2020.

Ehsan Azimi, *Interactive Platform for Medical Procedures in Mixed Reality*, The Johns Hopkins University, July 2020.

Jie Ying Wu, *Using High-Level Processing of Low-Level Signals to Actively Assist Surgeons with Intelligent Surgical Robots*, The Johns Hopkins University, August 2021.

Ph.D. Theses Advised (as secondary advisor or reader)

Ankur Kapoor, *Motion Constrained Control of Robots for Dexterous Surgical Tasks*, Computer Science, The Johns Hopkins University, August 2007.

Amen Ra Mashariki, *Development of a Model Driven Architecture and Software Quality Based Framework for a Robust Distributed Medical Software System*, Industrial Manufacturing and Information Engineering, Morgan State University, May 2008.

Marcin Balicki, *Augmentation Of Human Skill In Microsurgery*, Computer Science, The Johns Hopkins University, February 2014.

Paul Thienphrapa, *A Minimally Invasive Surgical System for 3D Ultrasound Guided Robotic Retrieval of Foreign Bodies from a Beating Heart*, Computer Science, The Johns Hopkins University, March 2014.

Wen Liu, *Augmented Reality and Intraoperative C-Arm Cone-Beam Computed Tomography for Image-Guided Robotic Surgery*, Computer Science, The Johns Hopkins University, June 2014.

Kevin Olds, *Robotic Assistant Systems for Otolaryngology-Head and Neck Surgery*, Biomedical Engineering, The Johns Hopkins University, March 2015.

Hyun Jae Kang, *Medical Ultrasound Imaging and Interventional Component (MUSiiC) Framework for Advanced Ultrasound Image-guided Therapy*, Computer Science, The Johns Hopkins University, July 2015.

Seth Billings, *Probabilistic Feature-Based Registration for Interventional Medicine*, Computer Science, The Johns Hopkins University, Aug. 2015.

Omid Mohareri, *Image and Haptic Guidance for Robot-Assisted Laparoscopic Surgery*, Electrical and Computer Engineering, University of British Columbia, Oct. 2015.

Jelena Frtunikj, *Safety Framework and Platform for Functions of Future Automotive E/E Systems*, Institute for Informatics, Technical University of Munich (TUM), June 2016.

Jonathan Bohren, *Intent-Recognition-Based Traded Control for Telerobotic Assembly over High-Latency Telemetry*, Dept. of Mechanical Engineering, Johns Hopkins University, Jan. 2017.

Piyamate Wisanuvej, *Robotic Manipulators for Single Access Surgery*, Dept. of Computing, Imperial College (London, UK), July 2018.

Preetham Chalasani, *Complementary Situational Awareness for an Intelligent Telerobotic Surgical Assistant System*, Dept. of Computer Science, Johns Hopkins University, Oct. 2018.

Adnan Munawar, *An Asynchronous Simulation Framework for Multi-User Interactive Collaboration: Application to Robot-Assisted Surgery*, Robotics Engineering, Worcester Polytechnic Institute, December 2019.

Kim Lindberg Schwaner, *Autonomy for Surgical Robot Systems*, University of Southern Denmark, September 2021.

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