Southwest Robotics Symposium 2019

January 24–25, 2019

robotics.asu.edu | swrobotics.engineering.asu.edu

Agenda

Thursday
January 24

8:30–9:00am	Check-in open, Coffee
9:00–9:30am	Welcome: **Dean Kyle Squires** Arizona State University
9:30–10:30am	**Plenary Speaker: Oussama Khatib** Stanford University
10:30–11:00am	Coffee Break / Posters / Company Demos

Session I: Robot Learning and AI

11:00–11:25am	**Yiannis Aloimonos** University of Maryland
11:25–11:50am	**Joel Burdick** California Institute of Technology
11:50–1:00pm	Lunch break / Faculty booths

Session II: Multi-Robot Systems

1:00–1:25pm	**Herbert Tanner** University of Delaware
1:25–1:50pm	**Rafael Fierro** University of New Mexico
1:50–2:15pm	**Nora Ayanian** University of Southern California
2:15–2:30pm	Coffee Break / Posters / Company Demos

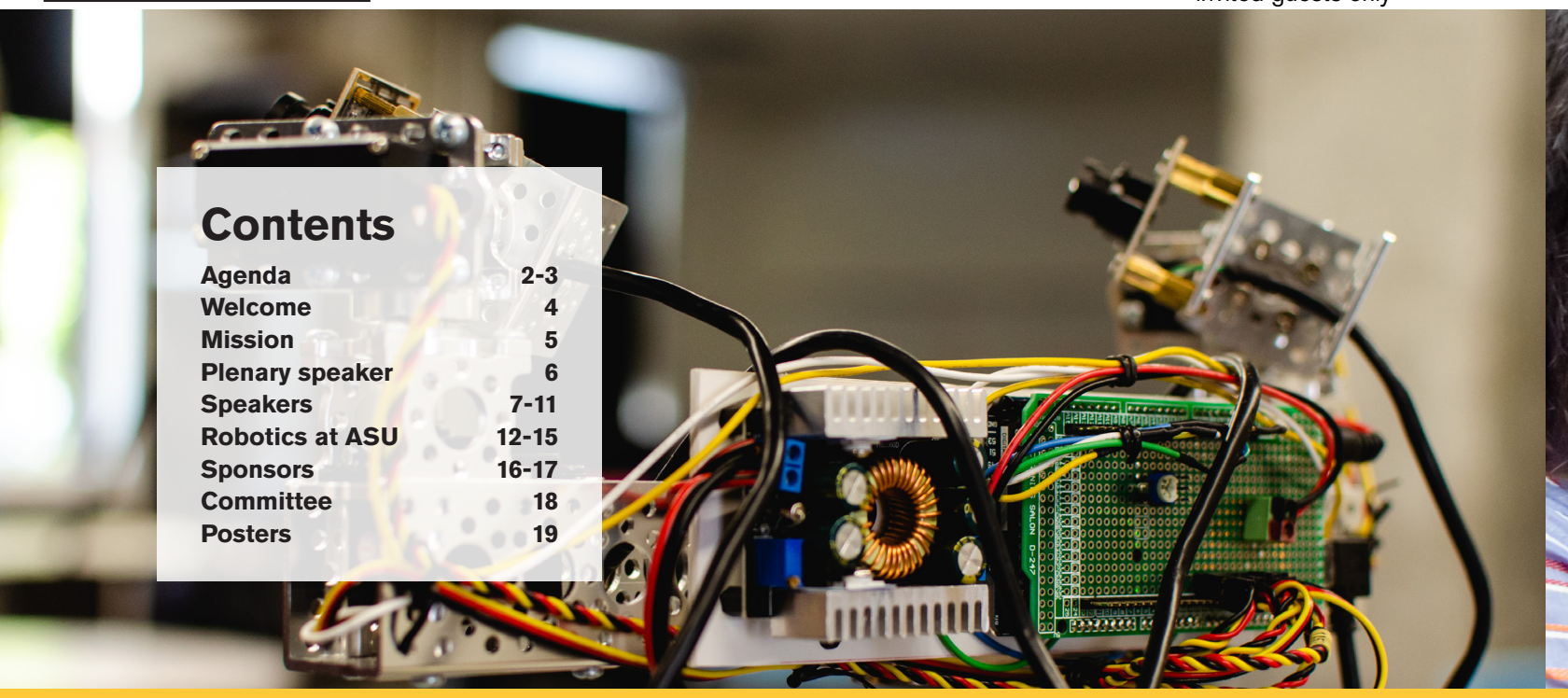
Session III: Bio-Inspired Robotics

2:30–2:55pm	**Barry Trimmer** Tufts University
2:55–3:20pm	**Jaydev Desai** Georgia Institute of Technology
3:20–4:10pm	What is happening @ASU? Talks by faculty
4:10–4:25pm	ASU Drone Studio unveiling presentation
4:25–6:00pm	Lab tours and ASU Drone Studio unveiling (Tempe campus)*
6:30pm	Dinner*

*invited guests only

What is happening @ASU speaker list:

- Panos Artemiadis
- Hyunglae Lee
- Heni Ben Amor
- Hamid Marvi
- Ted Pavlic
- Stephanie Gil



Contents

Friday
January 25

8:30–9:00am	Check-in open, Coffee
9:00–10:00am	**Plenary Speaker: Ruzena Bajcsy** University of California, Berkeley
10:00–10:15am	Coffee Break / Posters / Company Demos

Session IV: Autonomous Robotic Vehicles and Planning

10:15–10:40am	**Xiabo Tan** Michigan State University
10:40–11:05am	**Louis Whitcomb** Johns Hopkins University
11:05–11:20am	**Amit Goel** Nvidia
11:20–11:50am	Student Lightning Talks
11:50–1:15pm	Lunch break / Faculty booths

Session V: Human-Robot Interaction

1:15–1:40pm	**Michael Goldfarb** Vanderbilt University
1:40–2:05pm	**Marcia O'Malley** Rice University
2:05–2:20pm	**Bhawna Shiwani** Delsys
2:20–2:50pm	Coffee Break / Posters / Company Demos
2:50–3:40pm	What is happening @ASU? Talks by faculty
3:40–4:00pm	Wrap up / Discussion / Best poster award announcement
4:00–4:45pm	Transportation to ASU Polytechnic campus (with appetizers)*
4:45–6:00pm	Lab tours (Polytechnic campus)*
6:30pm	Dinner*

What is happening @ASU speaker list:

- Spring Berman
- Yezhou Yang
- Daniel Aukes
- Wenlong Zhang
- Georgios Fainekos

*invited guests only

Welcome

Welcome to the 2019 Southwest Robotics Symposium and Arizona State University. The main goal of the symposium is to build a community by fostering collaboration and promoting close interaction between leading researchers, engineers, technology adopters, while learning about state-of-the-art applications of robotics and autonomous systems.

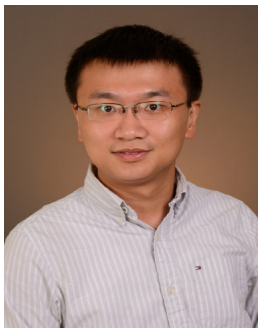
We have an engaging two-day agenda with keynote and regular presentations from leaders in the field of robotics as well as poster sessions, sponsor exhibits, live demos, and lab tours from several of our robotics faculty.

The Fulton Schools of Engineering continues to make significant investments in robotics and autonomous systems as we build the faculty expertise and unique capabilities needed to create innovative learning opportunities for students and a broadly based research portfolio characterized by foundational excellence and translational impacts. This year we are unveiling first to you a new space to support large-scale robotics experiments. The facility is over 10,000 square feet and equipped with over 100 motion cameras, making it among the largest indoor robotics testing spaces in US academic institutions. We look forward to the impact the space will support and partnerships that will enable. We are further excited about the educational impact we anticipate from our newly launched Master's program in Robotics and Autonomous Systems.

It is our sincere hope that your experience at the 2019 Southwest Robotics Symposium will prove to be informative and engaging and will result in the establishment of new contacts, connections, and collaborations. We are particularly grateful to our keynote and invited speakers for joining our symposium and sharing their experiences with us and to our faculty and students and industry sponsors for their generous support of our initiatives in robotics and autonomous systems.

Enjoy not only the research side of the symposium but also the hospitality of Arizona!

Panagiotis Polygerinos
General Chair
Assistant Professor
The Polytechnic School



Wenlong Zhang
General Chair
Assistant Professor
The Polytechnic School

Kyle Squires
Dean and Professor
Ira A. Fulton Schools of Engineering

Ira A. Fulton Schools of Engineering
Arizona State University

ASU Robotics

Our mission

Make change
Help drive positive change in society by connecting researchers at Arizona State University to collaboratively pursue advancements in robotics technologies, systems and education that will serve our most critical needs.

Solve problems
Explore the potential of robotics to help meet an array of challenges in the realms of health care, education, transportation, manufacturing, national defense, public safety, environmental health, communications, sustainable energy systems and earth and space exploration.

Leverage our community
Solve our problems more quickly and effectively by utilizing ASU's growing, multidisciplinary research community and expanding its impact by establishing high-quality research relationships with industry, government and the public.

Nurture the future
Nurture the next generation of robotics researchers through innovative educational practices, in-lab experiences and mentoring in entrepreneurship that create opportunities for students to develop their creative abilities, train them to be skilled problem solvers, and prepare them to establish themselves in the robotics community and in industry.

Southwest Robotics Symposium 2019

The Southwest Robotics Symposium will focus on the rapidly growing field of robotics. This 2-day event will include five sessions, posters, lab tours and demos, industry demos, and other opportunities to learn about the state-of-the-art in robotics research. Each session is focused on high-impact topics related to robotics and automation and will host talks from renowned researchers to discuss the state-of-the-art and future directions.

The session topics include:

- Robot Learning and AI
- Multi-Robot Systems
- Bio-inspired Robotics
- Autonomous Robotic Vehicles and Planning
- Human-Robot Interaction

Plenary Speaker – January 24

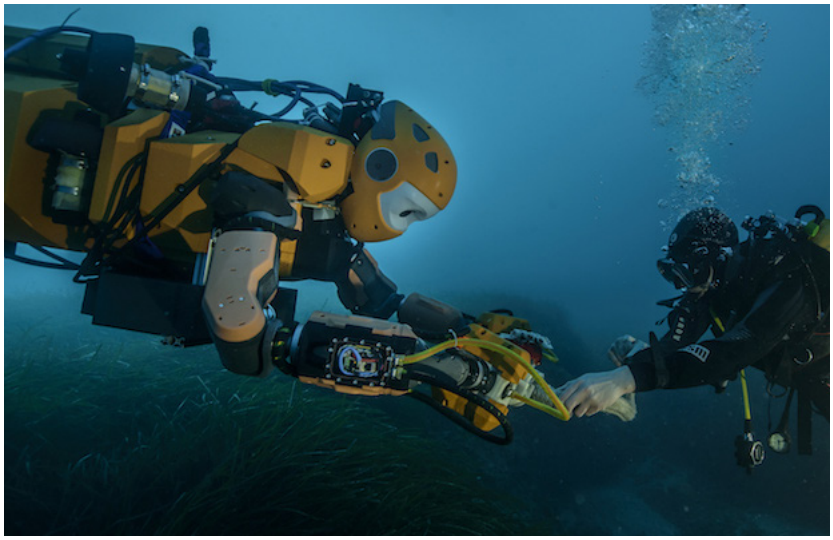
Oussama Khatib, PhD

Stanford University

Oussama Khatib received his Doctorate degree in Electrical Engineering from Sup'Aero, Toulouse, France, in 1980. He is Professor of Computer Science at Stanford University. His work on advanced robotics focuses on methodologies and technologies in human-centered robotics including humanoid control architectures, human motion synthesis, interactive dynamic simulation, haptics, and human-friendly robot design. He is Co-Editor of the Springer Tracts in Advanced Robotics series, and has served on the Editorial Boards of several journals as well as the Chair or Co-Chair of numerous international conferences. He co-edited the Springer Handbook of Robotics, which received the PROSE Award. He is a Fellow of IEEE and has served as a Distinguished Lecturer. He is the President of the International Foundation of Robotics Research (IFRR). Professor Khatib is a recipient of the Japan Robot Association (JARA) Award in Research and Development. In 2010 he received the IEEE RAS Pioneer Award in Robotics and Automation for his fundamental pioneering contributions in robotics research, visionary leadership, and life-long commitment to the field. Professor Khatib received the 2013 IEEE RAS Distinguished Service Award in recognition of his vision and leadership for the Robotics and Automation Society, in establishing and sustaining conferences in robotics and related areas, publishing influential monographs and handbooks and training and mentoring the next generation of leaders in robotics education and research. In 2014, Professor Khatib received the 2014 IEEE RAS George Saridis Leadership Award in Robotics and Automation.

The age of human–robot collaboration: deep sea exploration

Abstract: The promise of oceanic discovery has intrigued scientists and explorers for centuries, whether to study underwater ecology and climate change, or to uncover natural resources and historic secrets buried deep at archaeological sites. The discussion focuses on the development of Ocean One, a bimanual humanoid robotic diver that brings intuitive haptic physical interaction to oceanic environments. The robot was deployed in an expedition in the Mediterranean to Louis XIV's flagship Lune, lying off the coast of Toulon at ninety-one meters. Ocean One's demonstrated ability to distance humans physically from dangerous and unreachable spaces while connecting their skills, intuition, and experience to the task promises to fundamentally alter remote work. Robotic avatars will search for and acquire materials, build infrastructure, and perform disaster prevention and recovery operations - be it deep in oceans and mines, at mountain tops, or in space.



Plenary Speaker – January 25

Ruzena Bajcsy, PhD

University of California, Berkeley

Ruzena Bajcsy received the Master's and Ph.D. degrees in electrical engineering from Slovak Technical University, Bratislava, Slovak Republic, in 1957 and 1967, respectively, and the Ph.D. in computer science from Stanford University, Stanford, CA, in 1972. She is a Professor of Electrical Engineering and Computer Sciences and NEC chair holder at the University of California, Berkeley, and Director Emeritus of the Center for Information Technology Research in the Interest of Science (CITRIS). Prior to joining Berkeley, she was a professor of the Computer Science and information department at the University of Pennsylvania, Philadelphia. There she founded the GRASP (General Robotics and Active Perception) laboratory in 1979 which is flourishing now. In 1999 she was appointed to be headed the Computer and Information Science and Engineering Directorate at the National Science Foundation. In 2001 after she finished her stay at NSF, she retired form University of Pennsylvania and joined the faculty at University of California, Berkeley. Dr. Bajcsy is a member of the National Academy of Engineering and the National Academy of Science Institute of Medicine as well as a Fellow of the Association for Computing Machinery (ACM), fellow of IEEE and the American Association for Artificial Intelligence. In 2001, she received the ACM/Association for the Advancement of Artificial Intelligence Allen Newell Award. Since 2008 she is a member of the American Academy of Arts and Sciences. She is the recipient of the Benjamin Franklin Medal for Computer and Cognitive Sciences (2009) and the IEEE Robotics and Automation Award (2013) for her contributions in the field of robotics and automation. She received the 2016 NAE Simon Ramo Founders Award for her life achievements.

Predictive models of kinematic and dynamic of human and robotic physical activities

Abstract: First I will present an overview of the HART lab research activity. All of our efforts are focused one way or the other on studies of Cyber-physical systems including human as integrated component of such systems. Our focus is on Kinematic and dynamical models of human, specifically their musculoskeletal capabilities. This is work of R. Matthew, S. Seko, L. Hallock and Z. Cohen. This subgroup collaborates with the orthopedics group and neurology group in UC SF and MRI facilities at UCB. The above mentioned kinematic and dynamical models are facilitated by two recent developments:

(1) Availability of various relatively inexpensive/affordable and noninvasive devices that can deliver the necessary parameters of the position, velocity, acceleration, masses of not only the body but individual limbs, forces generated during various physical activities. These devices are not only the standard cameras, motion capture, force plates and force sensors, Inertial measuring devices, but also hand held ultrasound cameras, Electromyography, Acoustic Myography, real time MRI infrared sensors measuring oxygen in the blood. More advanced sensors are rapidly developing. (2) Mathematical and computational tools coming mainly from the field of robotics, control theory and optimization theory that afford to reliably process all the measurements, interpret them so that they generate the individual kinematic and dynamic predictive models of the physical performance of the individual. These models predict not only the physical performance of the individual but also delineate the weaknesses of the individual. (3) Our approach is to measure/estimate the kinematic/dynamic parameters, then model and based on the performance we design interventions, i.e assistive devices to help the individual better function in daily activities. In this presentation we will show, how we use measurement of the kinematic and dynamic parameters of the individual, we will be testing the validity of our approach/our predictive performance on both healthy Subjects here at UC Berkeley and UC San Francisco medical School. Our experimental paradigm is anchored in sit-to-stand exercise. The complementary activity of how to model active haptic perception as it applies to manipulation of soft objects with movable mass is the work of C. Chen while I. Huang is exploring a soft device to estimate the physical properties of the environment. Finally we apply these results and some acoustic measure to detect the Driver's attention. This is the work of Dr. Erickson. At the end of this presentation I will try to compare the research methodology of model based vs data base analysis in our context.

Speakers

Yiannis Aloimonos, University of Maryland

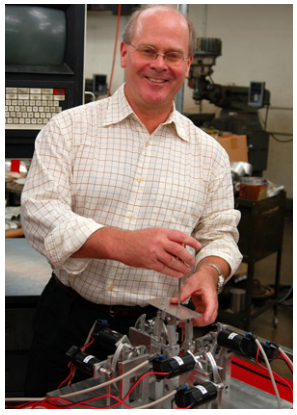
Title: The theory of primitives in cognitive robotics

Yiannis Aloimonos (prg.cs.umd.edu) is Professor of Computational Vision and Intelligence at the Department of Computer Science, University of Maryland, College Park, and the Director of the Computer Vision Laboratory at the Institute for Advanced Computer Studies (UMIACS). He is also affiliated with the Institute for Systems Research, the Neural and Cognitive Science Program and the Maryland Robotics Center. He was born in Sparta, Greece and studied Mathematics in Athens and Computer Science at the University of Rochester, NY (PhD 1990). He is interested in Active Perception, Autonomy and the modeling of vision as an active, dynamic process for real time robotic systems. For the past 10 years he has been working on bridging signals and symbols, specifically on the relationship of vision to reasoning, action and language.

Nora Ayanian, University of Southern California

Title: Crossing the reality gap: coordinating multirobot systems in the physical world

Nora Ayanian is Assistant Professor of Computer Science and Andrew and Erna Viterbi Early Career Chair at the University of Southern California. Her research focuses on creating end-to-end solutions for coordinating teams of robots that start from high-level specifications and deliver code for individual robots in the team, such as using simple multitouch inputs to control a team of UAVs. Her approach to multirobot systems creates unified solutions that concurrently address task assignment, path planning, and control, and that are broadly applicable across all aspects of multirobot systems and mobile sensor networks. Ayanian's work received the best student paper award at ICRA 2008, and recently, best paper in the robotics track at ICAPS 2016. In 2013 she was named one of IEEE Intelligent Systems "AI's 10 to watch" and in 2016, she was recognized as a visionary in MIT Technology Review's 35 Innovators Under 35 (TR35). Ayanian is a co-founder and current co-chair of the IEEE Robotics and Automation Society Technical Committee on Multi-Robot Systems.



Joel Burdick, California Institute of Technology

Title: Active learning for spinal cord injury therapy

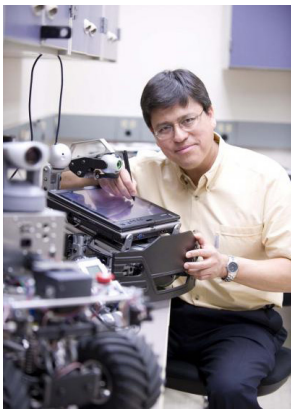
Joel Burdick is the Richard and Dorothy Hayman Professor of Mechanical Engineering and BioEngineering. He received his undergraduate degree in mechanical engineering from Duke University and M.S. and Ph.D. degrees in mechanical engineering from Stanford University. He has been with the department of Mechanical Engineering at the California Institute of Technology since May 1988, where he has been the recipient of the NSF Presidential Young Investigator award, the Office of Naval Research Young Investigator award, and the Feynman fellowship. Burdick has received the ASCIT award for excellence in undergraduate teaching and the GSA award for excellence in graduate education. He has been a finalist for the best paper award for the IEEE International Conference on Robotics and Automation in 1993, 1999, 2000, 2005, and 2016. He was appointed an IEEE Robotics Society Distinguished Lecturer in 2003, and received the Popular Mechanics Breakthrough award in 2011. Burdick's current research interests include robotic mobility in extreme terrains, multi-fingered robotic hand manipulation, the intersection of nonlinear control and machine learning, and rehabilitation of spinal cord injuries.

Jaydev Desai, Georgia Institute of Technology

Title: Flexible, 3D-printed robotic systems for surgical interventions

Jaydev P. Desai is currently a Professor and BME Distinguished Faculty Fellow in the Wallace H. Coulter Dept. of Biomedical Engineering at Georgia Tech. He is also the Director of the Georgia Center for Medical Robotics (GCMR) and the Associate Director of the Institute for Robotics and Intelligent Machines (IRIM). He completed his undergraduate studies from the IIT, Bombay, India, in 1993. He received his M.A. in Mathematics in 1997, M.S. and Ph.D. in Mech. Engineering and Applied Mechanics in 1995 and 1998 respectively, all from the UPenn. He was also a Post-Doctoral Fellow at Harvard University. He is a recipient of several NIH R01 grants, NSF CAREER award, and was also the lead inventor on the "Outstanding Invention in Physical Science Category" at the UMD, where he was formerly employed. He is also the recipient of the Ralph R. Teetor Educational Award. He has been an invited speaker at the NASciences "Distinctive Voices" seminar series and was also invited to attend the NAE's U.S. Frontiers of Engineering Symposium. He has over 160 publications, is the founding Editor-in-Chief of the Journal of Medical Robotics Research, and Editor-in-Chief of the Encyclopedia of Medical Robotics. His research interests are: image-guided surgical robotics, rehabilitation robotics, cancer diagnosis at the micro-scale, and endovascular robotics. He is a Fellow of IEEE, ASME and AIMBE.

Rafael Fierro, University of New Mexico



Title: Collaborative robotic teams

Rafael Fierro is a professor of the Department of Electrical and Computer Engineering, the University of New Mexico where he has been since 2007. He received an MSc. degree in control engineering from the University of Bradford, England and a Ph.D. degree in electrical engineering from the University of Texas at Arlington. Prior to joining UNM, he held a postdoctoral appointment with the GRASP Lab at the University of Pennsylvania and a faculty position with the Department of Electrical and Computer Engineering at Oklahoma State University. His current research interests include cyber-physical systems; coordination and planning in heterogeneous multi-agent systems; UAVs; and advanced manufacturing. His research has been funded by NSF, DOD, DOE, and Sandia National Laboratories. Dr. Fierro was the recipient of a Fulbright Scholarship, a 2004 National Science Foundation CAREER Award, and the 2008 International Society of Automation (ISA) Transactions Best Paper Award. He directs the AFRL-UNM Agile Manufacturing Center, and Multi-Agent, Robotics and Heterogeneous Systems (MARHES) Laboratory. Dr. Fierro is an associate editor for the IEEE Trans. on Automation Science and Engineering.

Michael Goldfarb, Vanderbilt University

Title: Lower limb exoskeleton and method of control for enhancing the mobility of poorly-ambulatory individuals

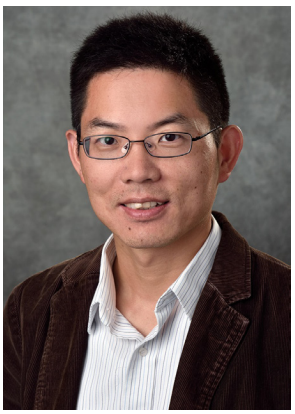
Michael Goldfarb is the H. Fort Flowers Professor of Mechanical Engineering, Professor of Electrical Engineering, and Professor of Physical Medicine and Rehabilitation at Vanderbilt University. Dr. Goldfarb conducts research on the design and control of robotic devices and systems that interact physically with people, and more specifically, on the design and control of intelligent assistive devices that improve quality of life for people with physical disabilities. Dr. Goldfarb has published more than 200 papers, including papers that were awarded best-paper awards in 1997, 1998, 2003, 2007, 2009, and 2013, and papers that were finalists for best paper awards in 2015 and 2017. Current and prior work includes the development of robotic limbs for upper and lower extremity amputees, and lower limb exoskeletons for individuals with spinal cord injury and stroke.

Speakers

Marcia O'Malley, Rice University

Title: Towards robots that teach and learn through physical human-robot interaction

Marcia O'Malley is the Stanley C. Moore Professor of Mechanical Engineering, of Computer Science, and of Electrical and Computer Engineering at Rice University. She currently serves as Special Advisor to the Provost on Educational and Research Initiatives in Collaborative Health. She is also the Director of Rehabilitation Engineering at TIRR-Memorial Hermann Hospital. Her research addresses issues that arise when humans physically interact with robotic systems, with a focus on training and rehabilitation in virtual environments. She is a Fellow of the American Society of Mechanical Engineers, and serves as an associate editor for the IEEE Transactions on Robotics and as a senior associate editor for the ACM Transactions on Human Robot Interaction.



Xiaobo Tan, Michigan State University

Title: Underwater patrol with gliding robotic fish "grace"

Dr. Xiaobo Tan is an MSU Foundation Professor in the Department of Electrical and Computer Engineering and Department of Mechanical Engineering (by courtesy) at Michigan State University (MSU). He received his bachelor's and master's degrees in automatic control from Tsinghua University, China, in 1995 and 1998, respectively, and his Ph.D. degree in electrical and computer engineering from the University of Maryland, College Park, in 2002. His research interests include bio-inspired underwater robots and their application to environmental sensing, soft robotics, and modeling and control of smart materials. He has published over 200 journal and conference papers and holds three US patents on these topics. Dr. Tan is a Fellow of IEEE, and a recipient of the NSF CAREER Award (2006), MSU Teacher-Scholar Award (2010), MSU College of Engineering Withrow Distinguished Scholar Award (2018), Distinguished Alumni Award from the ECE Department at University of Maryland (2018), and several Best Paper Awards. Dr. Tan is keen to integrate his research with educational and outreach activities, and has served as Curator of a robotic fish exhibit at MSU Museum in 2016-2017.

Herbert Tanner, University of Delaware

Title: Networked aerial detection of mobile radiation sources

Bert Tanner received his Ph.D. in mechanical engineering from the NTUA, Athens, Greece, in 2001. He was a postdoctoral researcher at the University of Pennsylvania from 2001 to 2003, and subsequently took a position as an assistant professor at the University of New Mexico. In 2008 he joined the Department of Mechanical Engineering at the University of Delaware, where he is currently a professor. Tanner received NSF's Career award in 2005. He is a fellow of the ASME, and a senior member of IEEE. He has served in the editorial boards of the IEEE Transactions on Automatic Control, the IEEE Robotics and Automation Magazine and the IEEE Transactions on Automation Science and Engineering. He is currently an associate editor for Automatica, and Nonlinear Analysis Hybrid Systems, and he is a chief specialty editor for Frontiers in Robotics and AI: multi-robot systems. He has also been serving in several conference editorial boards of both IEEE Control Systems and IEEE Robotics and Automation Societies.

Barry Trimmer, Tufts University

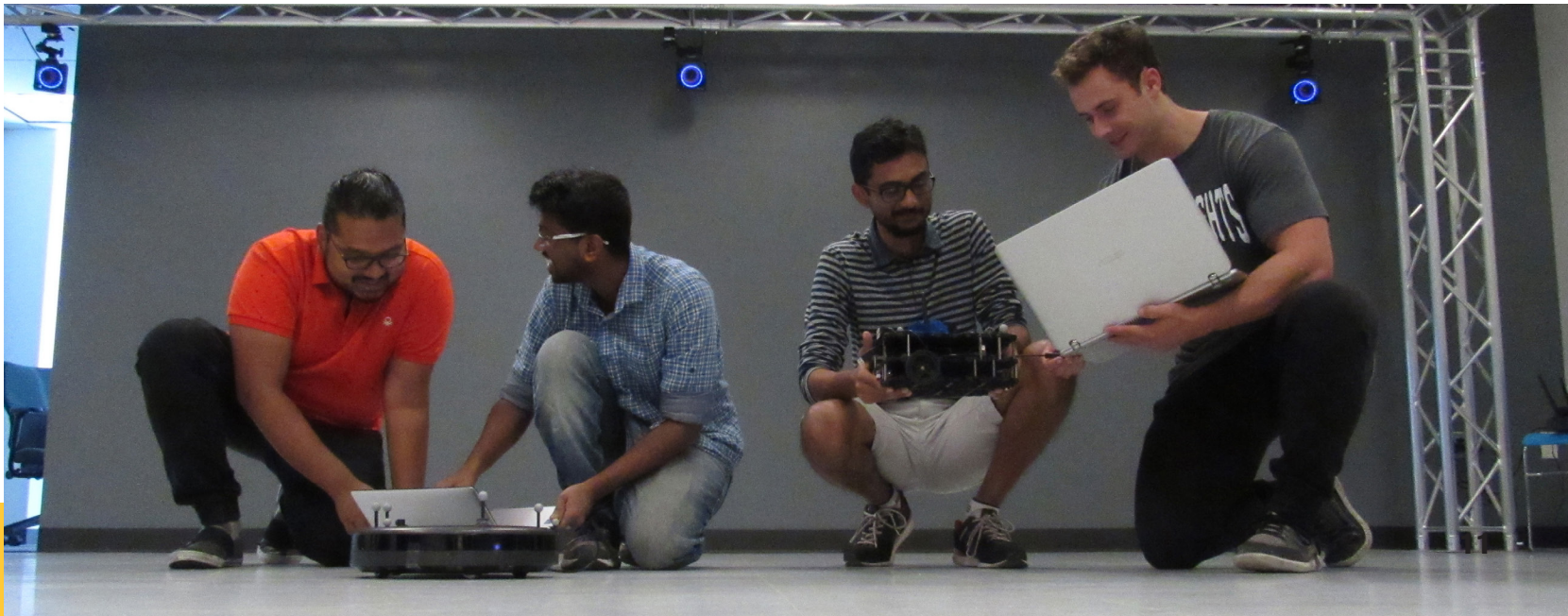
Title: Softworms: a non-pneumatic platform for highly deformable robot control

Barry Trimmer is the Henry Bromfield Pearson Professor of Natural Science at Tufts University. His research focus is on the Neuromechanics of Locomotion, the science of how animals control their movements. In addition to his work on living systems, Professor Trimmer is Director of the Tufts Neuromechanics and Biomimetic Devices Laboratory which specializes in the application of found biological principles to design and fabricate Soft Robots. Dr. Trimmer is also Editor in Chief of the journal Soft Robotics. His lab designs and builds a variety of soft robots that are used to test hypotheses about locomotion and to explore new types of control systems. His interests in living systems and robots converge in his recent research that seeks to "grow" robotic devices using a combination of biosynthetic materials, cellular modulation, and tissue engineering. These Biosynthetic Robots will be versatile, safe, biocompatible and biodegradable.

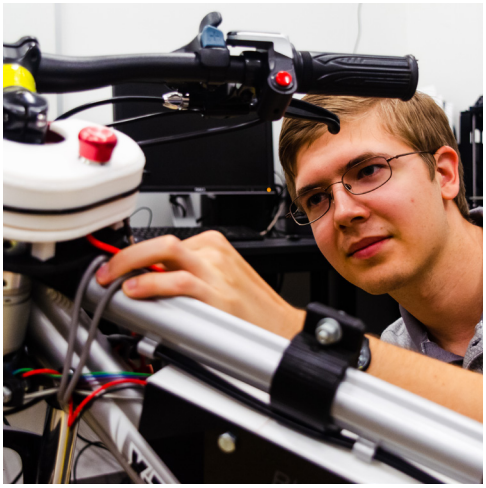
Louis Whitcomb, Johns Hopkins University

Title: Advances in design and control of underwater robotic vehicles for oceanographic exploration under polar ice

Louis L. Whitcomb is Professor and former Chairperson (2013-2017) of the Department of Mechanical Engineering, with secondary appointment in Computer Science, at the Johns Hopkins University's Whiting School of Engineering. He is an Adjunct Scientist, Department of Applied Ocean Physics and Engineering, Woods Hole Oceanographic Institution. He completed his Ph.D. in Electrical Engineering in 1992 at Yale University. He joined the Department of Mechanical Engineering at the Johns Hopkins University in 1995. His research focuses on the navigation, dynamics, and control of robot systems – with applications to robotics in extreme environments including space and underwater robots. Whitcomb is a co-principal investigator of the Nereus and Nereid Under-Ice Projects. He is the founding Director (2007-2013) of the JHU Laboratory for Computational Sensing and Robotics, the center of robotics research at JHU. He has received numerous best paper awards, teaching awards at JHU in 2001, 2002, 2004, and 2011, was the NSF Career Award, and the ONR Young Investigator Award. He is a Fellow of the IEEE.



Robotics Research at ASU



Human–Robot Control Interfaces

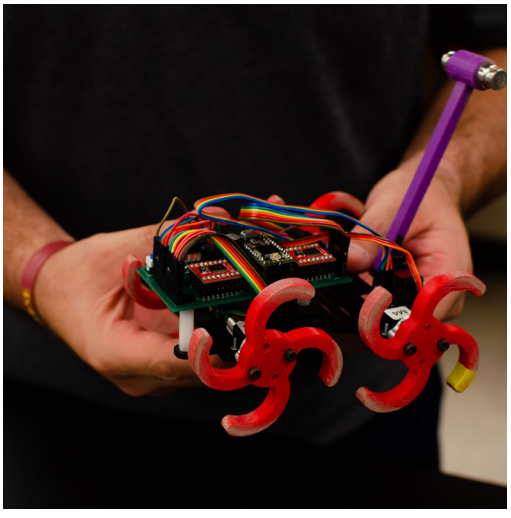
The human–robot control interfaces research programs in ASU address challenges related to devices and algorithms for effective and robust control interfaces between humans and robots. Our faculty pursue topics such as accurate and robust decoding of electromyographic and electroencephalographic signals to control prosthetic and orthotic devices. We also work on central and peripheral neural interfaces for closed-loop control of prosthetics for upper and lower limb amputees.

Panagiotis Artemiadis
Panagiotis Polygerinos
Tom Sugar
Wenlong Zhang

Wearable and Assistive Robotics

The wearable and assistive robotics research programs in ASU address challenges related to robotic systems that efficiently interact with the human body for augmentation of capabilities via intelligent and adaptive orthoses.

Panagiotis Artemiadis
Hyunglae Lee
Panagiotis Polygerinos
Marco Santello
Tom Sugar
Wenlong Zhang



Bio-Inspired Robotics

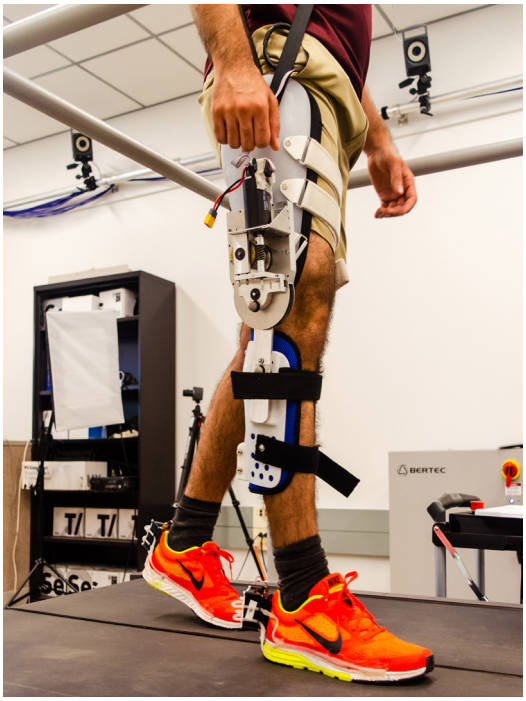
The bio-inspired robotics research programs in ASU address the development of new technologies and control approaches inspired by nature and embed these in robotic and autonomous systems. Our faculty study fundamental physics behind interactions of biological systems with their surrounding solid, granular, and fluidic environments. Utilizing biological insights derived from these studies, we develop bio-inspired robotic systems and smart interfacial structures for search and rescue, exploratory, and medical applications.

Dan Aukes
Spring Berman
Hamid Marvi
Ted Pavlic
Panagiotis Polygerinos

Rehabilitation Robotics

The robotics rehabilitation research programs in ASU address the development and control of novel devices for rehabilitation and assistance while advancing our knowledge of brain function and human sensorimotor control. Our faculty pursue topics such as the utilization of novel models of human gait utilized in robotic devices for providing gait rehabilitation at impaired walkers, primarily stroke survivors.

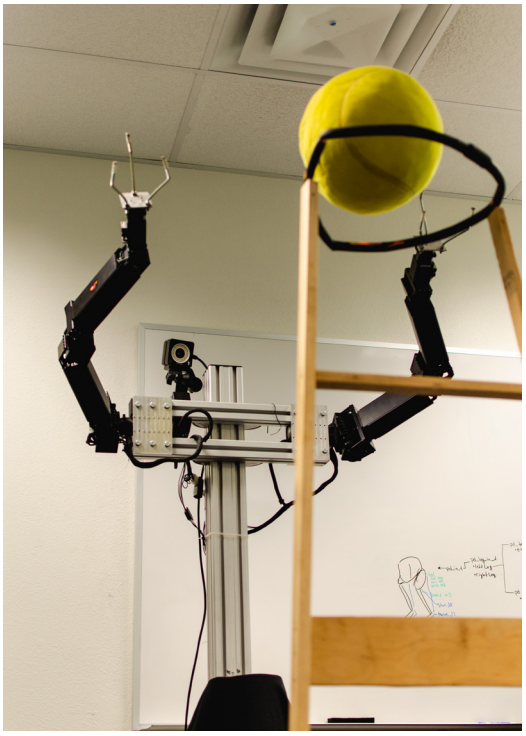
Panagiotis Artemiadis
Christopher Buneo
Claire Honeycutt
Hyunglae Lee
Thurmon Lockhart
Panagiotis Polygerinos
Tom Sugar
Wenlong Zhang



Cooperative Robotic Systems

The cooperative robotic systems research programs in ASU address cognitive challenges in human–robot collaboration by designing novel modeling and decision making methods that are transformative for human-robot interaction. Research is also done in distributed robotic systems that operate in complex and hazardous environments while advancing system autonomy via robust cooperative behaviors. Our faculty work on fundamental theories, practices and system integrations in human-aware and cognitive robotics, human–robot interaction and distributed robot systems with the goal to enable future robotic systems that augment human capabilities and enrich their lives.

Heni Ben Amor
Erin Chiou
Jnaneshwar Das
Stephanie Gil
Subbarao Kambhampati
Yi Ren
Siddharth Srivastava
Yezhou Yang
Sze Zheng Yong
Yu (“Tony”) Zhang
Wenlong Zhang



Robotics Research at ASU

Neural Engineering and Neuro-Rehabiliation

The neural engineering and neuro-rehabilitation research programs in ASU address the treatment of neural and cognitive deficits while pushing the boundaries of our knowledge of brain function. Our faculty pursues topics such as advancing treatments for stroke, improving adaptation to prosthetic devices, and exploring methods to prevent falls. We also work to expand our knowledge of healthy systems by investigating how neural circuits process sensory information, represent the state of the body in the world, and control complex actions like walking and using the hands to manipulate the environment. In addition, some of our faculty members explore sensorymotor processing and action control in cephalopods.

Jimmy Abbas

Chris Buneo

Bradley Greger

Claire Honeycutt

Hamid Marvi

Marco Santello

Steve Helms Tillery

Sze Zheng Yong

Swarm Robotic Systems

The swarm robotic systems research programs in ASU address the development of control and estimation strategies for robotic swarms that accommodate realistic constraints that will arise in practice. These strategies will enable swarms to perform tasks with a quantifiable degree of predictability in unknown environments with limited sensing, computation, localization, and communication. Our faculty also study the interaction between humans and swarms of robots for applications that range from military to search and rescue, surveillance and coverage. ASU is home to the largest indoor flying space for Unmanned Aerial Vehicles (UAVs) in the world, a 10,000 square feet facility, the ASU Drone Studio, which is equipped with a 105-camera motion capture system.

Panagiotis Artemiadis

Spring Berman

Stephanie Gil

Ted Pavlic

Artificial Intelligence and Cyber-Physical Systems

The artificial intelligence and Cyber-Physical Systems research programs in ASU focus on principles and applications of decision making and low level control for autonomous systems ranging from household robots to automated vehicles and beyond. Our core research focuses on computationally efficient methods that enable autonomous agents to accomplish complex user-assigned tasks by reasoning and acting over extended time horizons. In addition, we investigate issues related to percepetion, multi-robot coordination, embedded real-time control, networking, and safety verification.

Heni Ben Amor
Jnaneshwar Das
Georgios Fainekos
Stephanie Gil
Subbarao Kambhampati
Lina Karam
Ted Pavlic
Yi Ren
Aviral Shrivastava
Siddharth Srivastava
Kostas Tsakalis
Yezhou Yang
Sze Zheng Yong
Yu ("Tony") Zhang

Human Systems Integration

The human systems integration research programs investigate and develop technologies and best practices for the composition, training, management, and evaluation of human–machine systems, including heterogeneous teams of humans, AI, and robots. Our faculty pursue topics such as applied attention in human-machine interfaces, social affordances of human-machine collaboration in physical and cognitive work environments, team dynamics in support of national security, and determinants of learning outcomes in human–machine interactions. The goal is to cultivate effective and ethical partnerships between humans, AI, and robots working together in support of quality, safety, sustainability, and resilience.

Erin Chiou
Nancy Cooke
Scotty Craig
Robert Gutzwiller
Lina Karam
Ted Pavlic
Rod Roscoe

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Arizona Biomedical Research Center was established by the Arizona Legislature and signed into law by Governor Bruce Babbitt in 1994. ADCRC's mission was to fund investigators focused on diseases and health issues that impact the residents of Arizona. In 2005, the Arizona Disease Control Research Commission changed its name to the Arizona Biomedical Research Commission. In 2011 ABRC was placed under the direction of the Arizona Department of Health Services. ABRC is widely known for its grant funding to Arizona. In addition to providing competitively awarding funding for research in Arizona, ARBRC recognizes its role to help advance Arizona as a bioscience leader.

https://azdhs.gov/biomedical/

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www.ait-ai.com

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https://optitrack.com/

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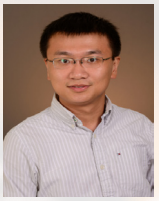

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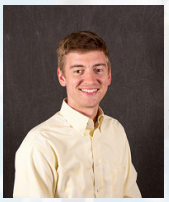

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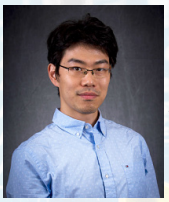

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Posters

*1. **Heterogeneous Multi-Agent Coordination with Optical Communication Link Constraints in Cluttered Environments**
S. Ahmad, L. Damodaran, R. Fierro / University of New Mexico

*2. **Augmenting a Miniature Humanoid Platform with a Low-cost Networked Computer Vision Framework**
D. Wallace, B. Hament, J. C. Vaz, P. Oh / University of Nevada, Las Vegas

*3. **Multi-agent Field Covering and Path Planning in Partially-Known Hex-Decomposd Environments**
X. Kan, K. Karydis / University of California, Riverside

*4. **Effects of Latency and Refresh Rate on Force Perception via Sensory Substitution by Force-Controlled Skin Deformation Feedback**
Z. A. Zook, A. M. Okamura, Y. Kamikawa / Rice University, Stanford University, Sony Corporation

*5. **Reimagining Human-Machine Interactions through Trust-based Feedback**
K. Akash, T. Reid, N. Jain / Purdue University

*6. **GAPLE: Generalizable Approaching Policy LEarning for Robotic Object Searching in Indoor Environment**
X. Ye, Z. Lin, J. Y. Lee, J. Zhang, S. Zheng, Y. Yang / Arizona State University, Adobe System, Inc.

*7. **Development of a Low Inertia Parallel Actuated Shoulder Exoskeleton Robot for the Characterization of Neuromuscular Properties during Static Posture and Dynamic Movement**
J. Hunt, H. Lee / Arizona State University

*8. **Neural Policy Translation for Robot Control**
S. Stepputtis, C. Baral, H. B. Amor / Arizona State University

*9. **Development of a Screw Propelled Vehicle for Mobility on the Lunar Simulant BP-1**
A. Thoesen, M. Green, D. Mick, T. McBryan, H. Marvi / Arizona State University

*10. **A Soft-Inflatable Exosuit to Assist Knee Swing During Walking**
S. Sridar, Z. Qiao, S. Poddar, W. Zhang, P. Polygerinos / Arizona State University

11. **Imitation of Human Motion through Motion Capture System**
Y. H. He, Y. Jun, P. Oh, / University of Nevada, Las Vegas, Rainbows Robotic

12. **Parallel Manipulator-Gripper for Mobile Manipulating UAVs**
D. Kim / University of Nevada, Las Vegas

13. **Stop and Go: Exploring Alternative Mechanisms for Dynamic Task Allocation in Multi Agent Systems - Response and Satisfaction Thresholds Trade Off Time Invested and Work Accomplished Differently**
C. Lynch, A. Dornhaus, R. Wilson / University of Arizona

14. **Improving User Performance in Haptics-Based Rehabilitation Exercises by Colocation of User's Visual and Motor Axes via a 3D Augmented-Reality Display**
R. Ocampo, M. Tavakoli / University of Alberta

15. **Kinesthetic Teaching of a Therapist's Behavior to a Rehabilitation Robot**
J. Fong, M. Tavakoli / University of Alberta

16. **Optimal Steering of Stochastic Mobile Robots that Undergo Collisions with their Environment**
Z. Lu, K. Karydis / University of California, Riverside

17. **Vertical Control for Underwater Robotics**
A. Gilbert, D. Aukes / Arizona State University

18. **Reconfigurable Soft Capacitor**
K. L. Dorsey / Smith College

19. **Cooperative Transport on Vertical Surfaces: Learning from Arboreal Ants**
A. Burchill, C. Reid, K. O'Meara / Arizona State University, Macquarie University

20. **A Soft Robotic Platform for Water Pipe Inspection**
W. Adams, P. Polygerinos / Arizona State University

21. **A Wearable Single-sensor System for Detecting Gait Impairments**
B. Shiwani, S. H. Roy, M. H. Saint-Hilaire, C. A. Thomas, P. Contessa, G. De Luca, J. C. Kline / Delsys, Inc and Altec, Inc, Boston University

22. **Training of Robotic Pectoral Fin Maneuvers Based on the CMAES Algorithm**
M. Sharifzadeh, D. Aukes / Arizona State University

23. **Fabric-Based Grippers Capable of Selective Distributive Bending for Assistance of Daily Living Tasks**
S. Amatya, P. H. Nguyen, S. Sridar, C. Thalman, P. Polygerinos / Arizona State University

24. **The Synthetic Teammate Project at the Center for Human, AI, and Robot Teaming**
N. Cooke, S. Berman, E. Chiou, L. Huang / Arizona State University

25. **Functionality of Octopus Suckers**
H. Bagheri, S. Cummings, C. Roy, R. Casleton, A. Wan, N. Erjavic, A. Hu, S. Berman, M. Peet, D. X. He, R. E. Fisher, H. Marvi / Arizona State University, University of California, Los Angeles, University of Arizona

26. **Localization of a Mobile Robot Swarm Using a Single LIDAR and Reciprocating Identification Rings**
M. Cavorsi, P. Artemiadis / Arizona State University

27. **Design and Evaluation of a Novel Two Degrees of Freedom Wearable Tactile System simulating Digit Normal and Shear Forces**
S. Toma, M. Santello, D. Shibata, D. Pratichizzo, F. Chinello / Arizona State University, University of New Mexico, University of Siena, Aarhus University

28. **Anticipatory Muscle Responses to Stepping on Compliant Surfaces: Towards Smart Ankle-Foot Prostheses**
E. Q. Yumbla, R. A. Obeng, J. Ward, T. Sugar, P. Artemiadis / Arizona State University, Spring Active Inc.

29. **Identification and Estimation of Swarm Intent via Partitions of System Dynamics**
Z. Jin, S. Hassaan, S. Z. Yong / Arizona State University

30. **BRAIN: An Industry-University Collaborative Research Center on Neurotechnologies**
M. Santello, J. Contreras-Vidal / Arizona State University, University of Houston

31. **Dynamic Modeling and Motion Control of a Soft Robotic Arm Segment**
Z. Qiao, P. H. Nguyen, P. Polygerinos, W. Zhang / Arizona State University

32. **Robust perception through robust adversarial training**
H. Yao, G. Nie, Z. Wang, Y. Yang, Y. Ren / Arizona State University

33. **Multimodal Inference for Human-Robot Scenarios**
J. Campbell, H. B. Amor / Arizona State University

34. **Robotic Ankle Training Using a Compliance-Controlled Mechanic Platform to Improve Paretic Ankle Motor Control in Subjects with Chronic Hemiparetic Stroke**
L. Hennington, V. Nalam, C. Kinney, M. Eikenberry, H. Lee / Arizona State University, Mayo Clinic, Midwestern University

35. **Rational Design of Soft, Thermally-Conductive Composite Liquid-Cooled Tubes for Enhanced Robotics and Wearable Electronics Cooling**
K. Rykaczewski, P. Kotagama, A. Phadnis, K. Manning / Arizona State University

36. **Decentralized Control of Distributed Actuation in a Soft Robot Arm**
A. Doroudchi, S. Shivakumar, S. Berman, M. M. Peet / Arizona State University

37. **Modeling, Control and Design of a Quadrotor Platform for Indoor Environments**
S. Lu, A. Altawaitan, A. Rodriquez / Arizona State University

38. **Requirements-based Testing of Autonomous Vehicles in Sim-ATAV**
C. E. Tuncali, G. Fainekos, D. Prokhorov, H. Ito, J. Kapinski / Arizona State University, Toyota Motor North America

39. **Neural Proxy of Mesh Distance for Asteroid Sculpting Robots**
A. Bernatskiy, C. Adami / Michigan State University

40. **Control Relevant System identification Using Multiple Short Data Records**
A. Shafique, R. Joshi, K. Tsakalis / Arizona State University

41. **Design and Control of a Laminate Quadrupedal Robot**
B. Shuch, T. Shafa, E. Rogers, D. Aukes, W. Zhang / Arizona State University

42. **Perturbation Robust Representations of Topological Persistence Diagrams**
A. Som, K. Thopalli, K. N. Ramamurthy, V. Venkataraman, A. Shukla, P. Turaga / Arizona State University, IBM, IIIT-Delhi

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