



The 2st International Workshop on Semiconductor Manufacturing Automation and Robotics

The Lewis P. and Julia Kiernan Conference Room (ECEC 202),
NJIT, Newark, NJ, USA
December 18th, 2023

Smart manufacturing systems incorporates various technologies, *i.e.*, automation, Internet of Things, big data analytics, system modeling, scheduling and control, and Artificial Intelligence (AI). Such technologies are permeating different aspects of manufacturing industry and make it smart and capable of addressing challenges such as interoperability, decentralization, distributed control, real-time manufacturing process control, service orientation, and maintenance optimization. As one of the most sophisticated manufacturing industries, semiconductor industry has been actively adopting such technologies to boost productivities.

This is a half-day workshop on semiconductor manufacturing automation (SMA) and robotics fully supported by SMA Technical Committee of IEEE Robotics & Automation Society and co-sponsored by the RAS Chapter of IEEE North Jersey Section and Technical Committee on AI-based Smart Manufacturing Systems, IEEE *Systems, Man, and Cybernetics* Society. The purpose of this workshop is to share with IEEE communities the recent advancement and development of robotics, semiconductor manufacturing technologies and relevant applications ranging from semiconductor tools scheduling, AI based defect detection and classification, smart equipment dispatch, intelligent process control, etc. The workshop aims to provide technical discussion forum for researchers from different fields and promote interdisciplinary and multidisciplinary research collaboration. It will also present the Best Paper Awards in the area of semiconductor manufacturing automation.

Workshop Chair

Yan Qiao, Macau University of Science and Technology

Organizing Chair

MengChu Zhou, New Jersey Institute of Technology
zhou@njit.edu

Secretary

Qi Deng, Tongji University and New Jersey Institute of Technology

2023 Workshop Program
8:50am - 12:00am, New York time, Monday, December 18th, 2023

ECEC 202, Newark, NJ 07102

<https://njit.webex.com/meet/zhou>

Time	Schedule
8:50-9:00 am	Opening and Announcement of Best Paper Awards
9:00-9:18 am	Invited Talk Crowdsourced Learning for Robot Physical Intelligence Cong Wang, Ph.D. and Associate Professor New Jersey Institute of Technology
9:18-9:36 am	Invited Talk Dynamic Machine Learning Inference for Mobile Robots Tao Han, Ph.D. and Associate Professor New Jersey Institute of Technology
9:36-9:54 am	Invited Talk Human-Robot Collaboration: A Sustainable Solution to the Future of Manufacturing Weitian Wang, Ph.D. and Associate Professor, Montclair State University.
9:54-10:12 am	Invited Talk Learning American Sign Language with AI Driven Grammar Checking YingLi Tian, Ph.D. and Distinguished Professor, City College of New York.
10:12-10:30 am	Invited Talk Source Seeking for Underactuated Vehicles Bo Wang, Ph.D. and Assistant Professor, City College of New York.
10:30-11:15 am	Keynote speech Robotic inspection of infrastructure using vision, ground penetrating radar (GPR) and impact-echo (IE) sensors Jizhong Xiao, Ph.D. and Professor, City College of New York
11:15-12:00 am	Keynote speech Emerging Trends in Vision-based Autonomous Robotics Cang Ye, Ph.D. and Professor, Virginia Commonwealth University.
12:00am	Lunch

Time: 9:00-9:18 am, Monday, December 18th, 2023
Title: Crowdsourced Learning for Robot Physical Intelligence

Cong Wang, Ph.D. and associate Professor, Electrical and Computer Engineering, New Jersey
Institute of Technology

Abstract

It takes a human newborn 1 to 2 years to learn motor skills as simple as turning knobs and stacking blocks, and it takes a human adult months to learn advanced skills such as acrobatic fidgeting. Humans also learn from a broad variety of knowledge sources. Compared to humans, robots still have quite primitive learning ability and should not be expected to develop strong physical intelligence by only learning from one or a few developers over a short period. The idea of Crowdsourced Surrogate Learning (CSL) systems, which allow robots to gradually learn physical skills while being teleoperated as surrogate machines by large groups of humans. CSL systems also actively shape the teleoperating skills of humans in ways that benefit robot learning.

Bio-sketch

Cong Wang is an associate professor in the ECE department at New Jersey Institute of Technology. Before joining NJIT in 2015, Dr. Wang was a Lecturer and Research Engineer at University of California, Berkeley. He obtained his PhD degree in the area of Controls and Dynamics from UC Berkeley in 2014, before which he attended Tsinghua University and obtained his master's degree in Automotive Engineering and bachelor's degree in Manufacturing Engineering and Automation in 2010 and 2008 respectively.

Time: 9:18-9:36 am, Monday, December 18th, 2023
Title: Dynamic Machine Learning Inference for Mobile Robots

Tao Han, Ph.D. and associate Professor, Electrical and Computer Engineering, New Jersey
Institute of Technology

Abstract

This talk highlights the growing integration of AI into mobile robots and edge devices. However, deploying AI algorithms on these devices comes with its own set of challenges. The speaker will delve into three dynamic machine-learning inference solutions tailored for mobile robots. First, the talk covers a dynamic inference mechanism that optimizes ML execution on edge devices. This mechanism efficiently reduces the consumption of computing resources on edge devices with a slight accuracy reduction by exploiting the spatial and depth redundancy of the input data. Second, the speaker presents an inference distribution method that allows multiple resource-constrained mobile edge devices to collaborate on running a large ML model. This method smartly splits the model and distributes computation among heterogeneous devices, considering varying computing resources and network connectivity. Third, a dynamic inference offloading approach is presented, optimizing the coordination of computation offloading across diverse edge devices. This approach introduces distributed control schemes and asynchronous global coordination to enable flexible and instant offloading control and model selection per user per request. In conclusion, the speaker provides insights into edge AI research, addressing the challenges of resource constraints, connectivity, and real-time performance.

Bio-sketch

Tao Han (M'15-SM'20) is an Associate Professor in the Department of Electrical and Computer Engineering at New Jersey Institute of Technology (NJIT) and an IEEE Senior Member. Before joining NJIT, Dr. Han was an Assistant Professor in the Department of Electrical and Computer Engineering at the University of North Carolina at Charlotte. Dr. Han received his Ph.D. in Electrical Engineering from NJIT in 2015 and is the recipient of NSF CAREER Award 2021, Newark College of Engineering Outstanding Dissertation Award 2016,

NJIT Hashimoto Prize 2015, and New Jersey Inventors Hall of Fame Graduate Student Award 2014. His papers win IEEE International Conference on Communications (ICC) Best Paper Award 2019 and IEEE Communications Society's Transmission, Access, and Optical Systems (TAOS) Best Paper Award 2019. His research interest includes mobile edge computing, machine learning, mobile X reality, 5G system, Internet of Things, and smart grid.

Time: 9:36-9:54 am, Monday, December 18th, 2023

Title: Human-Robot Collaboration: A Sustainable Solution to the Future of Manufacturing

Weitian Wang, Ph.D. and Associate Professor, the School of Computing, Montclair State University.

Abstract

Robotics technology has served humans in a large number of areas, especially in manufacturing and remanufacturing contexts. Global competitors and technological advancements result in great challenges and much more complicated working environments for manufacturing and remanufacturing. Human-robot collaboration (HRC) has numerous vital and outstanding advantages to substantially lessen the amount of fixed production costs in comparison to variable costs. HRC provides a great solution to complex hybrid manufacturing tasks. The cooperation of humans and robots in collaborative tasks can take advantage of the differing strengths of both sides. In this talk, I will give a brief introduction to robotics research and education at Montclair State University. Then I will share some of my research projects focusing on human-robot collaboration in smart manufacturing contexts including current challenges, the needs of HRC, robot learning from human demonstrations, human factors in human-robot collaboration, and new robot system development. Experimental results and discussions in real-world human-robot collaborative contexts will be presented.

Bio-sketch

Weitian Wang is an associate professor in the School of Computing at Montclair State University and the Director of Montclair Collaborative Robotics and Smart Systems Laboratory (CRoSS Lab) and NSF MRI MCROS Site. His research focuses on collaborative robotics, smart systems, and their synergistic CRoSS-disciplinary applications in smart manufacturing and remanufacturing, sustainabilities, healthcare, intelligent transportation, smart agriculture, aerospace, and interactive learning. Dr. Wang is the recipient of NSF CRII, MRI, ERI, and REU Awards. The results of his work have been published in multiple peer-reviewed international journals, book chapters, and conference proceedings. He received several IEEE/ASME Best Paper/Presentation/Mentor Awards. He is the recipient of Montclair State University Advising Excellence Faculty Advisor Award. Dr. Wang is an IEEE STEM Champion. He is enthusiastic about STEM education and develops numerous education and outreach programs for K-12, undergraduate, and graduate students. He is a senior member of IEEE.

Time: 9:54-10:12 am, Monday, December 18th, 2023

Title: Learning American Sign Language with AI Driven Grammar Checking

YingLi Tian, Ph.D. and Distinguished Professor, Electrical Engineering Department, City College of New York.

Abstract

American Sign Language (ASL) is a primary means of communication for over 500,000 people in the US, and a distinct language from English, conveyed through hands, facial expressions, and body movements. Most prior work on ASL recognition has focused on identifying a small set of simple signs performed, but current technology is not sufficiently accurate on continuous signing of sentences with an unrestricted vocabulary. In this talk, I will share our research of AI driven ASL learning tools to assist ASL students by enabling them to review and assess their

signing skills through immediate, automatic, outside-of-classroom feedback. Our system can identify linguistic/performance attributes of ASL without necessarily identifying the entire sequence of signs and automatically determine if a performance contains grammatical errors through fusion of multimodality (facial expression, hand gesture, and body pose) and multisensory information (RGB and Depth videos). The system currently can recognize 8 types of grammatical mistakes and is able to generate feedback for ASL learners on average in less than 2 minutes for each 1 minute ASL video. Our system has also been tested on videos recorded with cellphones and webcams.

Bio-sketch

YingLi Tian is a CUNY Distinguished Professor in Electrical Engineering Department at the City College of New York (CCNY) and Computer Science Department at Graduate Center of the City University of New York (CUNY). She is a Fellow of the Institute of Electrical and Electronics Engineers (IEEE), as well as a Fellow of International Association of Pattern Recognition (IAPR). Her research interests include computer vision, machine learning, artificial intelligence, assistive technology, medical imaging analysis, and remote sensing. She is a pioneer in automatic facial expression analysis, human activity understanding, and assistive technology. Before joining CCNY in 2008, Dr. Tian was a research staff member at IBM T. J. Watson Research Center and led the video analytics team. She received the IBM Outstanding Innovation Achievement Award in 2007 and the IBM Invention Achievement Awards from 2002 to 2007. She serves as an associate editor for IEEE Trans. on Multimedia (TMM), Computer Vision and Image Understanding (CVIU), Journal of Visual Communication and Image Representation (JVCI), and Machine Vision and Applications (MVAP).

Time: 10:12-10:30 am, Monday, December 18th, 2023

Title: Source Seeking for Underactuated Vehicles

Bo Wang, Ph.D. and Assistant Professor, Mechanical Engineering, City College of New York.

Abstract

This presentation mainly introduces a novel Extremum Seeking Control (ESC) method and explores its application in underactuated vehicle systems. The ESC-based controller stands out for its independence from position or velocity measurements of the vehicle. Instead, it relies only on real-time tracking of the source signal related to the current position. As a result, it proves highly adaptable to structure-free environments or areas lacking GPS or INS measurements. Potential use cases encompass distance-based positioning, avalanche victim search, and chemical/gas leak detection, among others.

Bio-sketch

Bo Wang is an Assistant Professor of Mechanical Engineering at The City College of New York. He received the Master of Science (MSc.) degree in Control Theory and Engineering from the University of Chinese Academy of Sciences, China, in 2018, and the Ph.D. degree in Mechanical Engineering from Villanova University in 2022. After receiving his Ph.D., he was a postdoctoral fellow at the University of Illinois Urbana-Champaign. His research interests include nonlinear control theory (robust, adaptive, and passive), underactuated systems, nonholonomic systems, geometric control theory, networked control systems, extremum seeking control, learning-based control, and robotics.

Time: 10:30-11:15 am, Monday, December 18th, 2023

Title: Robotic inspection of infrastructure using vision, ground penetrating radar (GPR) and impact-echo (IE) sensors

Jizhong Xiao, Ph.D. and Professor, Electrical Engineering, City College of New York.

Abstract

Numerous infrastructure (bridges, dams, highways, tunnels, etc.) in USA and around the world are reaching their life expectancy, and thus have strong needs for routine inspection and

maintenance to ensure sustainability. It is reported that 42% of over 600,000 highway bridges in the USA National Bridge Inventory (NBI) have exceeded their design life of 50 years, and 42,951 bridges are rated in poor condition and classified as “structurally deficient”. Although normal bridges are inspected biennially (deficient bridges are inspected annually), study has found that the visual inspection results can have a high level of inconsistency in identifying surface flaws. To inspect the structural integrity of bridges, the inspectors also need to detect subsurface defects (i.e., delamination, voids) using non-destructive evaluation (NDE) instruments such as GPR and impact-echo (IE) device at difficult to access components (i.e., pier, bottom side of the deck). The current practice of manual inspection using hand-held NDE devices by a “spider-man” with rope access, or by using scaffolding or snooper truck has to block traffic, and is expensive, time-consuming, and exposes human inspectors to dangerous situations. This presentation will introduce climbing robots developed over the years at CCNY Robotics Lab that integrate the robot control and vision-based accurate positioning with NDE signal processing to detect both surface flaws and subsurface defects. These robots combine the advantages of aerodynamic attraction and suction to achieve a desirable balance of strong adhesion and high mobility. For example, Rise-Rover with two drive modules can carry heavy payload up to 20 Kg, and GPR-Rover can carry a small GPR antenna for subsurface flaw detection and utility survey on concrete structures. Empowered by the capability of low cost vision-based accurate positioning, the GPR-Rover is able to scan the surface in arbitrary trajectories and tag GPR samples with position information that enables high-resolution 3D GPR imaging. The use of the robotic inspection tool will eliminate the time, hassle and cost to layout grid lines on flat terrain, and make it possible to automatically collect NDE data with minimum human intervention. These robots can reach difficult-to-access areas, take close-up pictures, perform contact-based NDE data collection for further analysis. This presentation will also introduce machine learning algorithms for visual inspection to detect and measure cracks; IE data processing methods that utilizes both learning-based and classical methods to interpret the IE data and reveal subsurface objects; and DNN-based GPR data analysis software to reveal subsurface targets for better visualization. The correlation of findings from multiple NDE sensors (visual, IE and GPR) on board the robot gives a comprehensive evaluation of concrete structures. Field tests demonstrate that the robotic inspection system significantly increases the data collection speed, and make the full bridge inspection faster, safer, and cheaper without affecting traffic flow on roadways.

Bio-sketch

Jizhong Xiao is Professor of Electrical Engineering at the City College of New York (CCNY/CUNY City College), the flagship campus of City University of New York (CUNY). He is the Director of CCNY Robotics Lab and Co-Founder of InnovBot LLC, a CUNY Spin-off company dedicated to R&D and commercialization of robotic and NDE technologies with application to the inspection of infrastructure and wind turbine blades. He received Ph.D. degree from the Michigan State University in 2002, He has published more than 200 research articles in peer reviewed journal and conferences. He received NSF CAREER Award in 2007 and CCNY Outstanding Mentoring Award in 2011, Humboldt Research Fellowship in 2013~2015, and Dean’s Award for Excellence in 2019.

Time: 11:15-12:00 am, Monday, December 18th, 2023

Title: Emerging Trends in Vision-based Autonomous Robotics

Cang Ye, Ph.D. and Professor, Department of Computer Science, Virginia Commonwealth University.

Abstract

In this talk, I will first discuss the NSF’s Foundational Research in Robotics program. The topics include what the FRR program is about, what has been funded, what research it is looking for, and what is considered a responsive proposal for the program. Then, I will discuss the limitations of current vision-based robots and the challenges facing vision-based robot autonomy. Finally, I will talk about a few emerging research trends in the area. Several robotic

platforms, including autonomous cars, underwater robots, and assistive robots, will be used as examples to showcase how new sensors and/or machine-learning techniques can be integrated into the robotic system to create new or significantly improved robotic capabilities.

Bio-sketch

Cang Ye received the B. Eng. and M. Eng. degrees from the University of Science and Technology of China and the Ph.D. degree from the University of Hong Kong. He is currently a Professor in the Department of Computer Science at Virginia Commonwealth University. Before joining VCU, he was a Professor with the Department of Systems Engineering at the University of Arkansas at Little Rock. His research interests include vision-based navigation of autonomous systems, assistive/ rehabilitation robotics, human-robot interaction, and machine learning for robot navigation. His research has been funded by NSF, NIH, DOT and NASA, and received several best paper awards at conferences. Dr. Ye is a Fellow of AIMBE, a senior member of IEEE, and a member of ACM. He is also a member of the Technical Committee on Robotics and Intelligent Sensing of the IEEE SMC Society. He serves as an Editorial Advisory Board member and Associate/Guest Editor of numerous international journals in robotics and control. Dr. Ye has been an NSF Program Director since January 2023. His program responsibilities include Foundational Research in Robotics, Robust Intelligence, and Safe-Learning Enabled Systems.