UNIVERSITY of VIRGINIA
SCHOOL of ENGINEERING & APPLIED SCIENCE
Department of Computer Science

International Workshop on

NEXT-GENERATION CYBER-PHYSICAL SYSTEMS

A workshop in celebration of
Professor Jack Stankovic's 70th birthday
and his achievements in Cyber-Physical Systems.

September 15, 2018
University of Virginia

Workshop agenda

Darden School of Business • 100 Darden Boulevard, Charlottesville, VA 22903

8:30-9:00AM Breakfast (Outside Classroom 140)
Fruit, bagels with cream cheese, coffee, tea, water, juices

9:00-9:15AM Opening remarks (Classroom 140)
Pamela Norris (Executive Dean, School of Engineering and Applied Science at UVA)
Wei Zhao (American University of Sharjah) - *Misconceptions about Jack Stankovic*

9:15-10:30AM Session 1 (Classroom 140)
Chair: Wei Zhao (American University of Sharjah)

- *Reliable Self-Driving Vehicles: Quintessential Next-Gen Cyber-Physical Systems*
  Raj Rajkumar (CMU)

- *Real-Time Virtual Resources in the Cloud*
  Al Mok (UT Austin)

- *Cyber-Physical Systems: Frontiers and Misconceptions*
  Tarek Abdelzaher (UIUC)

11:00AM-12:00PM Session 2 (Classroom 140)
Chair: Shahriar Nirjon (UNC)

- *Dependable Industrial Internet of Things*
  Chenyang Lu (Washington University in St. Louis)

- *Back to the Future: Digital Circuit Design in the FinFET Era*
  Mircea R. Stan (ECE, UVA)

- *A Historical Revisit of Jack's VigilNet*
  Tian He (University of Minnesota)

- *Conductive Stretchable Fabric-Based Body Motion Sensing and Feedback*
  Gang Zhou (College of William and Mary)

12:00-2:00PM Lunch (South Lounge)
All you can eat Lunch Buffet includes choices from salad and sandwich bars, daily soup, daily hot entrées and dessert bar with beverage service. Buffet will be set up in the Abbot Center Dining Room across from the South Lounge.

2:00-3:00PM Panel Discussion Session 3: *Future of Cyber-Physical Systems* (Classroom 140)
Chenyang Lu (moderator), Tarek Abdelzaher, Chris Gill, Al Mok, and Raj Rajkumar

3:30-4:30PM Session 4 (Classroom 140)
Chair: Gang Zhou (College of William and Mary)

- *DeepRacing AI: Teaching Autonomous Vehicles to Handle Edge Cases in Traffic*
  Madhur Behl (UVA)
- *Quality-Time-Advantage-based Key Establishment Protocols for Securing Wireless CPS*
  Yong Guan (Iowa State)
- *Towards Safe and Trustworthy Cyber-Physical Systems*
  Lu Feng (UVA)
- *Resilient Cyber-Physical Systems by Advanced Sensing and Computing*
  Rui Tan (NTU, Singapore)
- *Dynamic Policies for Wireless Sensor-Actuator Networks*
  Octav Chipara (Iowa)
- *Machine Learning for Constrained Devices with Limited Training Data*
  Asif Salekin (UVA)
- *Cyber-Physical Systems for Smart Cities: a Mobility Perspective*
  Desheng Zhang (Rutgers University)

5:00-6:00PM Cocktail reception (Pepsico Forum)
Petite Crab Cake with Chipotle Aioli, Petite Beef Wellington, Potato Pancake with Roasted Eggplant, Grilled Shrimp, Avocado and Goat Cheese Crostini, Vegetarian Stuffed Mushrooms

6:00-9:00PM Banquet buffet dinner (South Lounge)
Mixed Green Salad with Spiced Pecans, Red Onions, Grape Tomatoes, Cucumber and Balsamic Vinaigrette; Grilled Salmon with Pineapple Salsa; Eggplant Parmesan
Roasted Garlic Mashed Potatoes; Grilled Asparagus

- Opening remarks
- Video and remarks (Introduction: Meiyi Ma)
- Speech by Jack Stankovic (Introduction: Chenyang Lu)
- Special guest Phil Trella

Morning talk descriptions

Openining Remarks
Pamela Norris | University of Virginia

Biography: Pamela Norris is the Executive Associate Dean of Research in the School of Engineering and Applied Science and the Frederick Tracy Morse Professor of Mechanical and Aerospace Engineering. After receiving her PhD from Ga Tech in 1992 and completing post-doctoral studies at UC Berkeley with Chang-Lin Tien, she joined the faculty at UVA in 1994, where she founded both the Nanoscale Energy Transfer Lab and the Aerogel Research Lab. Today, she is recognized globally as a leading expert in both research fields. She routinely chairs, and speaks at, international conferences on those subjects and has published over 100 heavily cited referred journal papers. She holds patents for applications of aerogels in areas ranging from biological warfare detection, to lab-on-a-chip, to thermal insulation, along with patents for innovative thermal management techniques for jet-blast deflectors. She has served as the PI or Co-PI on over 45 sponsored research projects representing well over $25M from DOD, NSF, Industry and Foundations. She typically supervises a few undergraduate theses each year and has advised 24 doctoral students, 26 master's degree students, and many research assistants. Pam is well-known for her mentoring skills and for her dedication to increasing the representation and retention of women faculty in the STEM disciplines, serving now as the Director of UVA's NSF ADVANCE Institutional Transformation program. In 2016 she was honored with the Society of Women Engineers Distinguished Engineering Educator Award "for enduring, positive influence on students' lives as a gifted teacher, mentor, and role model; and for promoting greater diversity in STEM higher education".

Opening Remarks: Misconceptions about Jack Stankovic
Wei Zhao | American University of Sharjah

Biography: An internationally renowned scholar, Professor Wei Zhao is currently serving the American University of Sharjah as its Chief Research Officer. From 2008 to 2018, he served as the eighth Rector of the University of Macau. Professor Zhao also served as the Dean of the School of Science at Rensselaer Polytechnic Institute, Director for the Division of Computer and Network Systems in the U.S. National Science Foundation, and Senior Associate Vice President for Research at Texas A&M University. Professor Zhao completed his undergraduate studies in physics at Shaanxi Normal University, China, in 1977, and received his MSc and PhD degrees in Computer and Information Sciences at the University of Massachusetts at Amherst in 1983 and 1986, respectively. An IEEE Fellow, Professor Zhao has made significant contributions in cyber-physical system, distributed computing, real-time systems, computer networks, and cyberspace security. He led the effort to define research agenda of and to create the very first research funding program for cyber-physical systems, when he served as the NSF CNS Division Director in 2006. His research group has received numerous awards. Their research results have been adopted in

the standard of SAFENET (Survivable Adaptable Fiber Optic Embedded Network). In 2011, he was named by the Chinese Ministry of Science and Technology as the Chief Scientist of the national 973 Internet of Things Project.Professor Zhao was awarded the Lifelong Achievement Award by the Oversea Chinese Association of Science and Technology in 2005. In 2007, he was honored with the Overseas Achievement Award by the Chinese Computer Federation. Professor Zhao has been conferredhonorable doctorates by 12 universities in the world and academician of the International Eurasian Academy of Sciences.

Reliable Self-Driving Vehicles: Quintessential Next-Gen Cyber-Physical Systems

Raj Rajkumar | CMU

Abstract: This talk will focus on challenges that next-generation cyber-physical systems face: dealing with the uncertainties of the physical world we live in, dealing with cyber-physical security issues, and handling both cooperation and communications with other entities in the environment that may or may not be trustable. These issues manifest themselves vividly in the context of connected and automated vehicles.

Biography: Prof. Raj Rajkumar is the George Westinghouse Professor of Electrical & Computer Engineering and Robotics Institute at Carnegie Mellon University. At Carnegie Mellon, he directs the USDOT National University Transportation Center on Safety, Mobility21 – the USDOT National University Transportation Center on Mobility and Metro21, CMU's Smart Cities Initiative. He also directs the Real-Time and Multimedia Systems Laboratory, and co-directs the General Motors-Carnegie Mellon Connected and Autonomous Driving Collaborative Research Laboratory (CAD-CRL) at Carnegie Mellon University. Raj has served as the Program Chair and General Chair of six international ACM/IEEE conferences on real-time systems, wireless sensor networks, cyber-physical systems and multimedia computing/networking. He has authored one book, edited another book, holds three US patents, and has more than 160 publications in peer-reviewed forums. Nine of these publications have received Best Paper Awards. He has given several keynotes and distinguished lectures at several international conferences and universities. He is a Fellow of the National Academy of Inventors, an IEEE Fellow, a co-recipient of the IEEE Simon Ramo Medal, and an ACM Distinguished Engineer. He has been given an Outstanding Technical Achievement and Leadership Award by the IEEE Technical Committee on Real-Time Systems. Prof Rajkumar's work has influenced many commercial operating systems. He was also the founder of Ottomatika Inc., a company that delivered the software intelligence for self-driving vehicles. Ottomatika was acquired by Delphi. His research interests include all aspects of cyber-physical systems with a particular emphasis on self-driving vehicles.

Real-Time Virtual Resources in the Cloud

Al Mok| University of Texas at Austin

Abstract: Traditional real-time system research often assumes a closed or embedded system environment where the availability of resources and the worst-case resource demand of the applications are known a priori, e.g., the AIMS system of the Boeing 777. This is not the case in the cloud environment where the number of users (e.g., the number of autonomous vehicles in a convoy) nor the resources required to meet specific timing constraints (e.g., the complexity of manufacturing tasks in a robotic manufacturing factory) are fixed at design time. Thus there is a need for throttling the peak load on the system and tailoring the system load to the availability of resources at hand in order to meet all the timing constraint commitments. Scalability requires analysis of per user/task resource bounds for composite tasks and the modularization of resources to meet the real-time requirements of the accommodated users. Toward this direction, we shall discuss the formalization of the resource allocation/scheduling problem for the open-system environment and a scalable solution strategy using the concept of real-time virtual resource.

Biography: Dr. Aloysius Mok is Quincy Lee Centennial Professor of Computer Science at the University of Texas at Austin. He is best known for his research work in real-time systems and is a pioneer of the area of cyber-physical systems (CPS), having assisted the National Science Foundation to establish the NSF research program in CPS. Dr. Mok is a past recipient of the IEEE TC on Real-Time Systems Award, and he has been commended by the Director, Defense Research and Engineering for his contribution to the avionics advisory team of the F/A-22 aircraft. Dr. Mok got all his degrees from MIT.

Cyber-Physical Systems: Frontiers and Misconceptions

Tarek Abdelzaher | University of Illinois at Urbana Champaign

Abstract: The talk is a speaker's reflection on recent history, current advances, and emerging trends in cyber-physical systems, as well as lessons learned over the course of two decades on best practices for cyber-physical systems research. The talk offers observations, predictions, and general advice for success in this quickly-evolving research field. In an acknowledgment to the speaker's own source of inspiration, the talk covers "misconceptions" encountered along the way.

Biography: Tarek Abdelzaher received his Ph.D. in Computer Science from the University of Michigan in 1999. He is currently a Professor and Willett Faculty Scholar at the Department of Computer Science, the University of Illinois at Urbana Champaign. He has authored/coauthored more than 200 refereed publications in real-time computing, distributed systems, sensor networks, and control. He is an Editor-in-Chief of the Journal of Real-Time Systems, and has served as Associate Editor of the IEEE Transactions on Mobile Computing, IEEE Transactions on Parallel and Distributed Systems, IEEE Embedded Systems Letters, the ACM Transaction on Sensor Networks, and the Ad Hoc Networks Journal. He chaired (as Program or General Chair) several conferences in his area including RTAS, RTSS, IPSN, Sensys, DCoSS, ICDCS, and ICAC. Abdelzaher's research interests lie broadly in understanding

and influencing performance and temporal properties of networked embedded, social and software systems in the face of increasing complexity, distribution, and degree of interaction with an external physical environment. Tarek Abdelzaher is a recipient of the IEEE Outstanding Technical Achievement and Leadership Award in Real-time Systems (2012), the Xerox Award for Faculty Research (2011), as well as several best paper awards. He is a member of IEEE and ACM.

Dependable Industrial Internet of Things

Chenyang Lu | Washington University in St. Louis

Abstract: IoT-driven control underpins numerous cyber-physical systems from Industrial Internet to smart cities. In contrast to best-effort IoT often found in consumer markets, there remain daunting challenges to develop IoT systems that must not only monitor but also control physical systems in a dependable fashion. We will highlight the dependability challenges caused by communication delays, data loss and resource constraints of IoT. We will further discuss cyber-physical co-design as a fundamental approach to achieve dependability in IoT-driven control systems.

Biography: Chenyang Lu is the Fullgraf Professor at Washington University in St. Louis. His research interests include Internet of Things, embedded real-time systems, and cyber-physical systems. Professor Lu's current work focuses on real-time cloud, industrial cyber-physical systems and Internet of Medical Things. In the area of real-time cloud, he led the development of RT-Xen, a real-time hypervisor scheduler that has been incorporated in the popular Xen hypervisor. In the area of industrial cyber-physical systems, his research advanced real-time wireless networks and cyber-physical co-design for dependable wireless control systems. In the area of Internet of Medical Things, he piloted one of the world's first large-scale wireless sensor networks for clinical monitoring. Professor Lu served as Editor-in-Chief of ACM Transactions on Sensor Networks from 2011 to 2017 and currently chairs the IEEE Technical Committee on Real-Time Systems (TCRTS). He received the Ph.D. degree under Professor Jack Stankovic from UVA in 2001. He is a Fellow of IEEE.

Back to the Future: Digital Circuit Design in the FinFET Era

Mircea R. Stan | University of Virginia

Abstract: It has been less than a decade since FinFET devices were first introduced in full production, but, as we enter the sub-10nm era, FinFETs are becoming dominant in most of the high-end products. As the transition from planar devices to FinFETs is still ongoing, it is important for digital circuit designers to understand finFET devices as they pose many new design challenges and some of the design knobs from the planar device era aren't applicable anymore. This presentation will cover some of these challenges and opportunities while making detailed comparisons across multiple technology nodes ranging from "old-time" bulk technology to advanced planar technology node such as Fully Depleted Silicon-on-Insulator (FDSOI), to FinFETs. For FinFETs, we consider both state-of-art industry-standard nodes and also predictive nodes that can guide us to the future. Our study shows that besides performance

and power benefits, FinFET devices show significant reduction of short-channel effects and extremely low leakage, and many of the electrical properties are as good or better than those in old long channel technology nodes. FinFETs have put scaling back on track by moving in the third dimension. Moving forward, FinFETs offer a bright future and are an indispensable technology for a wide range of applications from high-end performance-critical computing to energy-constrained mobile applications and smart Internet-of-Things (IoT) devices.

Biography: Mircea R. Stan is a Professor in the Charles L. Brown Department of ECE at UVA, where he is teaching and doing research in the areas of high-performance low-power VLSI, temperature-aware circuits and architecture, embedded systems, spintronics, and nanoelectronics. He leads the High-Performance Low-Power (HPLP) lab and is an associate director of the Center for Automata Processing (CAP). He has more than eight years of industrial experience, has been a visiting faculty at UC Berkeley in 2004-2005, at IBM in 2000, and at Intel in 2002 and 1999. He has received the NSF CAREER award in 1997 and was a co-author on best paper awards at SELSE 2017, ISQED 2008, GLSVLSI 2006, ISCA 2003 and SHAMAN 2002. He gave conference keynotes at SOCC 2016, CNNA 2014, WoNDP 2015 and iNIS 2015. Prof. Stan is a fellow of the IEEE, a member of ACM, and of Eta Kappa Nu, Phi Kappa Phi and Sigma Xi.

A Historical Revisit of Jack's VigilNet

Tian He | University of Minnesota

Abstract: VigilNet is one of the major efforts in the sensor network community to build an integrated sensor network system for surveillance missions 15 years ago lead by Prof. John A. Stankovic. This talk gives a historical revisit of the design, development and deployment of VigilNet. Over a decade, Jack's system design principles and philosophy reflected in VigilNet has influenced not only generations of his students, but also the large research community. The other key contributors of this system (in alphabetical orders) are Tarek Abdelzaher, Brian Blum, Qing Cao, Qin Chen, Qiuhua Cao, Lin Gu, Tian He, Jonathan Hui, Sudha Krishnamurthy, Bruce Krogh, Chenyang Lu, Liqian Luo, Leo Selavo, Liu Sha, Sang Son, Radu Stoleru, Pascal Vicaire, Anthony Wood, Ting Yan, and Ronghua Zhang.

Biography: Dr. Tian He received the Ph.D. degree under Professor John Stankovic from UVA in 2004. He is currently a full professor in the Department of Computer Science and Engineering at the University of Minnesota-Twin Cities. He is an IEEE Fellow.

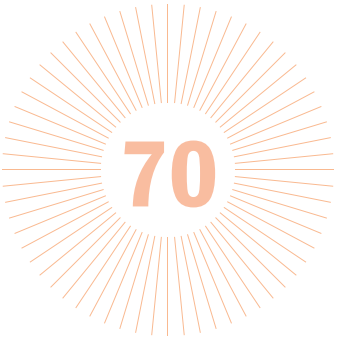
Conductive Stretchable Fabric-Based Body Motion Sensing and Feedback

Gang Zhou | College of William and Mary

Abstract: Existing body motion sensing methods mainly rely on micro-electrical-mechanical sensors such as accelerometer and gyroscope. These sensors are often embedded into wearable devices (glasses, watch/wristband, ring, necklace, belt, shoes, etc.) which may be invasive and uncomfortable for long-term wear. In addition, it is inconvenient to wear multiple devices simultaneously for whole body motion sensing. We will present our preliminary thoughts on conductive stretchable fabric-based body motion sensing and feedback. Conductive stretchable fabric is made from nylon/spandex and is comfortable to wear. The fabric is coated with a conductive polymer. When stretched, its resistance changes. Based on this observation, we propose to detect joint angles by measuring the resistance change of conductive stretchable fabric and computing its corresponding stretch distance.

Then, we integrate multiple joint angle sensors into a jumpsuit to synchronously track position trajectories of different body joints in a predefined coordinate system, and to estimate 3D whole body motion accordingly. Plus, we will introduce our prototype of joint angle sensor and its application on volleyball arm swing monitoring and feedback. Finally, we will present related Cyber-Physical System research questions and brainstorm potential solutions.

Biography: Dr. Gang Zhou is an Associate Professor in the Computer Science Department at William & Mary. He served as Graduate Program Director of this department during 2015~2017. He received his Ph.D. from UVA in 2007 under Professor John Stankovic. He has published more than 100 papers in the areas of wireless networks, sensor systems, internet of things, smart health, ubiquitous & mobile computing. There are over 7300 citations of his papers per Google Scholar. He also has 17 papers each of which has been cited more than 100 times since 2004. He serves or served on the Journal Editorial Board of (1) ACM Transactions on Sensor Networks, (2) IEEE Internet of Things, (3) Elsevier Computer Networks, and (4) Elsevier Smart Health. He is ACM/IEEE CHASE 2018 TPC co-Chair. He served as NSF, NIH, and GENI proposal review panelists multiple times. He received an award for his outstanding service to IEEE Instrumentation and Measurement Society in 2008. He is a recipient of the Best Paper Award of IEEE ICNP 2010. He received NSF CAREER Award in 2013. He received a 2015 Plumeri Award for Faculty Excellence.



Afternoon talk descriptions

DeepRacing AI: Teaching Autonomous Vehicles to Handle Edge Cases in Traffic
Madhur Behl | University of Virginia

Abstract: What would an autonomous car do if another vehicle swerves across multiple lanes without any indication? How about a high speed lane merge? or when the car in front of you brakes aggressively without warning? Or an obstacle appears at the last second in front of the car? One of the main obstacles with self-driving cars is, how to ensure that the car drives safely, and reliably in situations that don't happen often in day to day driving, and are therefore difficult to gather data on. Fully autonomous driving really requires correct decision-making under unexpected situations. A car trained to follow the 'rules of the road' will perform well most of the time, but it is the unusual conditions, the edge cases, that pose the hardest safety challenges. This is becoming increasingly critical as many of the algorithms which the car relies on to understand and asses traffic situations, and in some cases even issue control commands, they in turn rely on the knowledge of historical traffic situations that the car has seen and driven through before.

This talk will describe the research being done at the UVA Cyber-Physical Systems Link Lab, where we are teaching autonomous cars to learn how to drive at the limits of the control, and agility of the vehicle. The way we do that is by autonomously racing these cars against each other, both in highly photorealistic simulation and then on the 1/10 scale. Driving fast, and driving safely may seem as two very contradictory objectives, but the idea is not to drive fast all times, but enhance the autonomous vehicle with the ability to be able to brake aggressively and maneuver aggressively, when it encounters a safety critical situation.

Biography: Madhur Behl is an assistant professor in the departments of Computer Science, and Systems and Information Engineering, and a member of the Cyber-Physical Systems Link Lab at UVA. His research interests focus on modeling, control, safety, and implementation of Energy, Medical, and Automotive Cyber-Physical Systems, especially at the confluence of machine learning, control systems, real-time embedded systems, and optimization. Applications of his work include predictive modeling and control for Smart Cities, Building Automation, and Safety and Trust in Autonomous Vehicles. Before joining UVA, he was a research fellow at Penn and the Co-Founder of Expresso Logic - a NSF SBIR small business. He received his Ph.D. (2015) and M.S. (2012), in Electrical and Systems Engineering, both from the University of Pennsylvania. Dr. Behl is the winner of the American Control Conference (ACC 2017) Best Energy Systems Paper Award, TECHCON Best Paper Award (2015), and the best demo award at BuildSys, 2012. In 2016 he won the Department of Energy's Allegheny Cleantech university prize. In 2011, he won the World Embedded Software Contest held in Seoul by the Korean Ministry of Knowledge Economy. He is also the recipient of the Richard K. Dentel Memorial Prize awarded by the University of Pennsylvania for research and excellence in urban transportation.

Quality-Time-Advantage-based Key Establishment Protocols for Securing Wireless CPS

Yong Guan | Iowa State University

Abstract: The essence of information assurance resides in the ability to establish secret keys between the legitimate communicating parties. Common approaches to key establishment include public-key infrastructure, key-distribution centers, physical-layer security, or key extraction from common randomness. Of these, the latter two are based on specific natural advantages that the legitimate parties hold over their adversaries – most often, such advantages rely on superior or privileged communication channels. Our efforts in this work tackle a key-establishment protocol that relies on a completely different type of advantage: time. The protocol builds on the idea that when two devices are able to spend a pre-determined, mostly uninterrupted, interval of time in the company of each other, and when such a feat is outside the capability of any realistic attacker, then the legitimate parties should be able to establish a secret key without any prior common information. In this talk, we will present a basic efficient time-based key establishment protocol, and demonstrate how it can be extended to follow customized information transfer functions and deal with predictable fluctuations of wireless interference. This line of research starting from our Adopted-Pet protocol to the most recent ACM WiSec 2018 results, will create new research opportunities and paradigms in securing the next-generation wireless CPS systems.

Biography: Dr. Yong Guan is a professor of Electrical and Computer Engineering, the Associate Director for Research of Information Assurance Center at Iowa State University, and Cyber Forensics Coordinator of the NIST Center of Excellence in Forensic Sciences – CSAFE. He received his Ph.D. degree in Computer Science from Texas A&M University in 2002, MS and BS degrees in Computer Science from Peking University in 1996 and 1990, respectively. With the support of NSF, IARPA, NIST, and ARO, his research focuses on security and privacy issues, including digital forensics, network security, and privacy-enhancing technologies for the Internet. The resulted solutions have addressed issues in attack attribution, secure network coding, key management, localization, computer forensics, anonymity, and online frauds detection. He served as the general chair of 2008 IEEE Symposium on Security and Privacy (SP/Oakland 2008), co-organizer for ARO Workshop on Digital Forensics, and the co-coordinator of Digital Forensics Working Group at NSA/DHS CAE Principals Meetings. Dr. Guan has been recognized by awards including NSF Career Award, ISU Award for Early Achievement in Research, the Litton Industries Professorship, and the Outstanding Community Service Award of IEEE Technical Committee on Security and Privacy.

Towards Safe and Trustworthy Cyber-Physical Systems

Lu Feng | University of Virginia

Abstract: Cyber-physical systems (CPS) are increasingly everywhere, providing new capabilities to improve quality of life and transform many critical areas. However, significant new challenges are also posed for assuring the safety, trustworthiness and performance of CPS, due to the increasing complexity and scale, uncertainties of human interactions, etc. In this talk, I will present my approaches on modeling, design and analysis of CPS to tackle some of these challenges, with a particular focus on human-in-the-loop CPS.

Biography: Lu Feng is an Assistant Professor at the Department of Computer Science at the University of Virginia. She is also a member of the Link Lab at UVa. Previously, she was a postdoctoral fellow at the University of Pennsylvania and received her PhD in Computer Science from the University of Oxford. She has received several awards for her research, including NSF CISE CRII Award, James S. McDonnell Foundation Postdoctoral Fellowship, Rising Stars in EECS, UK Engineering and Physical Sciences Research Council Scholarship, and Cambridge Trust Scholarship.

Resilient Cyber-Physical Systems by Advanced Sensing and Computing

Rui Tan | Nanyang Technological University

Abstract: Cyber-physical systems (CPSes) are engineered systems built from and depend upon the synergy of physical and computational components. As the ability of a system to maintain acceptable performance in the presence of disturbances, faults, and attacks, resilience is a key desired property of safety-critical CPSes such as utility infrastructures and manufacturing systems. Although resilience has been extensively studied for sensing, networking, and actuation, the tight link between cyber and physical components in CPSes introduces new research challenges and opportunities for achieving system resilience. In this talk, I will introduce our ongoing projects and recent results on using power grid frequency fluctuations to achieve resilient timestamping and clock synchronization for embedded and wearable devices as well as false data injection attacks against cyber-physical control systems.

Biography: Rui Tan is an Assistant Professor at School of Computer Science and Engineering, Nanyang Technological University. Previously, he was a Senior Research Scientist at Advanced Digital Sciences Center, a Singapore-based research center of University of Illinois at Urbana-Champaign, and a postdoctoral Research Associate at Michigan State University. He received PhD degree from City University of Hong Kong. His research interests include sensor networks, Internet of things, and cyber-physical systems. He is the recipients of IPSN'17 and CPSR-SG'17 Best Paper Awards, IPSN'14 and PerCom'13 Best Paper Award Runner-Ups, and CityU HK Outstanding Academic Performance Award.

Dynamic Policies for Wireless Sensor-Actuator Networks

Octav Chipara | University of Iowa

Abstract: Wireless sensor-actuator networks (WSANs) are gaining rapid adoption in process control industries such as oil refineries, chemical plants, and factories. WSANs provide a low-cost and versatile alternative to wired networks for connecting sensors, actuators, and controllers as part of feedback-control loops. Since communication delays and packet losses may lead to severe degradation of control performance or even instability of the system, it is critical to developing wireless solutions that provide reliable and real-time communication while remaining agile in the face of network dynamics. To this end, researchers have proposed a wide range of transmission scheduling techniques to ensure reliable and real-time communication. However, these methods employ fixed transmission schedules which are difficult to adapt in response to network dynamics. To improve the performance of wireless networks, we propose to transition from using static schedules where nodes performed transmissions that are determined apriori to dynamic policies where nodes determine what packets to transmit based on the state of the network. We will discuss how such policies can be constructed to improve the real-time capacity of a network without sacrificing its reliability. The discussion will include an analytical technique to determine bounds the worst-case response time of a network.

Biography: Octav Chipara is an Assistant Professor in the Department of Computer Science at the University of Iowa and part of the Aging Mind and Brain Initiative. He received his Ph.D. from Washington University in St. Louis and completed his Postdoctoral Fellowship at the University of California San Diego. He is the recipient of the NSF CAREER Award (2018). His research focuses on the systems, networking, and software engineering aspects of developing mobile health (mHealth) systems that continuously monitor and infer the health status of patients in spite of operating in dynamic environments and on limited battery resources. The central theme of his research is that to harness the full potential of mHealth systems, computer scientists must have better tools for programming and analyzing their properties.
His work combines the design of communication protocols, middleware, and software tools with large-scale real-world deployments of working systems. His research is supported by the National Science Foundation, National Institutes for Health, Department of Justice, and the Roy J. Carver Foundation.

Machine Learning for Constrained Devices with Limited Training Data

Asif Salekin | University of Virginia

Abstract: With the increasing interest in smart car, smart home, smart health-care, and smart cities, we are moving toward a smart world. Advancement of body-worn sensors have motivated extensive research to develop human event detection technologies in smart IoT devices. Implementing large-scale deep neural networks with high computational complexity on low-cost IoT devices is constrained by limited computational resource. This disjunction makes the conventional state-of-art deep learning algorithms incompatible with IoT world. Additionally, human event detection in realistic applications (in real-world settings) is challenging due to

environmental and behavioral uncertainties, environmental noise, inability of sensors to perceive all aspects of a human event, difficulty to annotate human events, such as mental disorders, emotions, etc., and limitations of real training data in realistic environments. The goal of this talk is to present novel solutions to deploy the mainstream neural networks on resource constrained devices with limited training data, addressing the challenges of human event detection in real-word applications.

Biography: Asif Salekin is a PhD candidate in the Department of Computer Science at UVA. His research takes a multi-disciplinary approach to develop novel and practical human behavioral event sensing technologies that capture observable low-level physical signals from human bodies and surrounding environments in the form of acoustic and electromagnetic waves (from IMU sensors), and employ new deep learning, machine learning, signal processing and natural language processing techniques (on transcribed speech-text), to rethink the core mechanisms of existing human behavioral event sensing technologies. Asif's research has been well-accepted by a diverse set of communities. He has published his works at the leading conferences in the fields of ubiquitous computing, connected health, and wireless sensor networks. He has 13 peer-reviewed full papers (8 first-author) and 2 of his first-author full papers are in submission. Recently, he received the Graduate Student Award for Outstanding Research from UVA, Department of Computer Science. His work, AsthmaGuide, was nominated for the best paper award in the Wireless Health-2016 conference. Additionally, Asif has the experience of working in two leading research labs (Nokia Bell Labs, Bosch Research) as a research intern. An US patent has been submitted from his internship work in Bosch Research.

Cyber-Physical Systems for Smart Cities: a Mobility Perspective

Desheng Zhang | Rutgers University

Abstract: For the first time ever, we have more people living in urban areas than in rural areas. Based on this inevitable urbanization, the research in our group aims to address sustainability challenges related to urban mobility (e.g., energy consumption and traffic congestion) by data-driven applications with a Cyber-Physical-Systems approach (CPS, also known as a broader term for the Internet of Things). Under the context of the smart cities initiative proposed by the White House, in this talk, I will focus on data-driven modeling and applications for large-scale cross-domain urban systems, e.g., taxi, bus, subway, private vehicle, truck,cellphone, and smart payment systems. I will first show how cross-domain data from these systems can be collaboratively utilized to capture urban mobility in real time by a new technique called multi-view bounding, which addresses overfitting issues of existing mobility models driven by single-domain data. Then I will show how the captured real-time mobility can be used to design a practical service, i.e., mobility-driven ridesharing, to provide positive feedback to urban systems themselves, e.g., reducing energy consumption and traffic congestion. Finally, I will present some research challenges related to future urban CPS in the context of the smart cities research.

Biography: Desheng Zhang is an Assistant Professor at the Department of Computer Science at Rutgers University. Previously, he was offered the Senseable City Consortium Postdoctoral Fellowship from MIT and awarded his Ph.D. in Computer Science from the University of Minnesota. His research is uniquely built upon 100 TB urban data from 10 kinds of cross-domain urban systems, including cellphone, smartcard, taxi, bus, truck, subway, bike, personal vehicle, electric vehicle, and road networks in 8 cities across 3 continents with 100 million urban residents involved. Desheng designs and implements large-scale data-driven models and real-world services to address urban sustainability challenges. Desheng has published more than 60 papers in premium Computer Science venues, e.g., MobiCom, UbiComp, SenSys, IPSN, ICCPS, SIGSPATIAL, ICDCS, RTSS, BIGDATA and 6 best paper/thesis/poster awards.

Banquet Special Guest Speaker | Phil Trella

Phil Trella is Assistant Vice President for Graduate Studies. His work focuses on enhancing graduate student and postdoctoral recruitment and retention, and upon coordinating university-wide efforts in graduate studies and postdoctoral affairs. To this end, one of Phil's primary concerns is the promotion of more integrated cultures among both graduate students and postdoctoral researchers at UVa. To meet these goals he is working to increase fellowship opportunities that stimulate innovative and multidisciplinary research, to enhance diversity within the ranks of graduate students and postdocs, and to broaden and strengthen the university's efforts in career development and placement.

Phil earned his Ph.D. in anthropology in 2010 from the University of Virginia. His research interests include ancient food production systems, the disintegration of complex societies, and long-term environmental change. He has conducted anthropological and archaeological research in the North America, Europe, and the Middle East. As an undergraduate he studied abroad and participated in research in northern Finland where he developed an ongoing interest in the lives of pastoral peoples. More recent archaeological research concerns the "collapse" of some of the world's first cities across northern Iraq, northern Syria, and southeastern Turkey at the close of the third millennium B.C.

Before joining the staff at VPR Phil held a postdoc position with the Sciences Humanities and Arts Network for Technological Initiatives (SHANTI) where he worked to advance digital scholarship among faculty and graduate students at UVA.

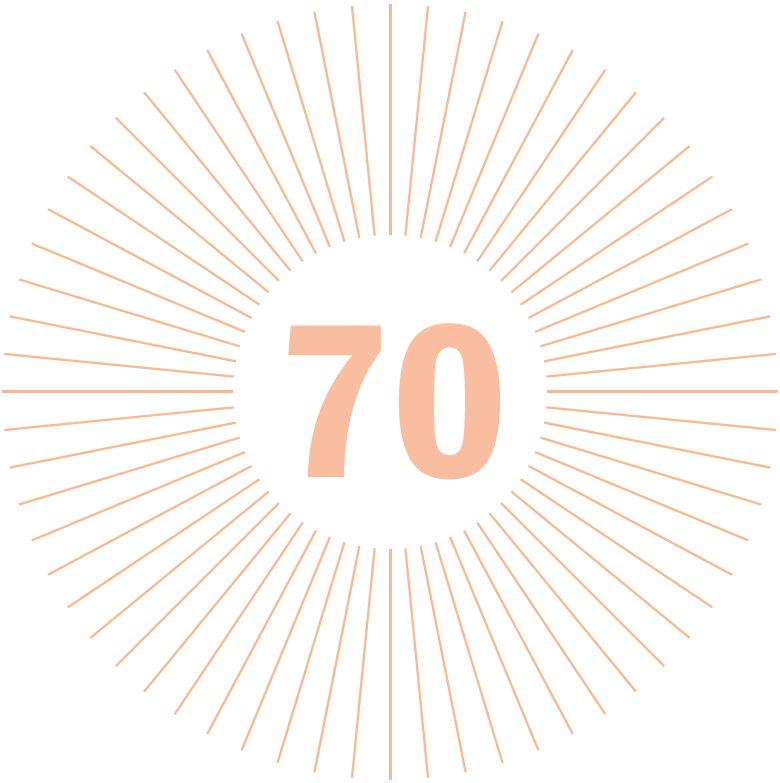
Thank you for attending.

Happy Birthday

Jack!

Sign up for the event's **Facebook group** to view and share your photos and videos from the event. Search for "***CPS Workshop & Jack's 70th Birthday***".

Learn about local events and places to go while you're in Charlottesville at ***visitcharlottesville.org***!



UNIVERSITY of VIRGINIA

SCHOOL of ENGINEERING & APPLIED SCIENCE
Department of Computer Science