Co-organizers:

Thought-leadership Series:

AI and Robotics for Garment Industry

24 Feb 2023 (Fri) | HKT (GMT +8) 14:00 – 17:10

In-person at HK Science Park & Online via Zoom | English

Event Name: Thought-leadership Series - AI and Robotics for Garment Industry

Date: 24 February 2023 (Friday)

Time: 14:00 – 17:10 (HKT GMT+8)

Format: In-person at INNO^2 & Online via ZOOM

Venue: INNO^2, 2/F, Building 17W, Hong Kong Science Park

Co- Organisers: Hong Kong Science and Technology Parks Corporation
Centre for Transformative Garment Production
JC STEM Lab of Robotics for Soft Materials

RUNDOWN

13:45 – 14:00	**Online and On-site registration Starts**
14:00 – 14:05	**Welcoming Remarks by Mr. Albert Wong** *Chief Executive Officer, Hong Kong Science & Technology Parks Corporation*
14:05 - 14:15	**Opening Remarks** **By Prof. Norman Tien** *Managing Director, Centre for Transformative Garment Production* *Taikoo Professor of Engineering and Chair Professor of Microsystems Technology, The University of Hong Kong*
14:15 - 14:30	**Topic: Fabric Modelling** **By Prof. Taku Komura** *Professor, Department of Computer Science, The University of Hong Kong*
14:30 - 14:45	**Topic: Planning and Learning for Human-robot Collaboration** **By Prof. Jia Pan** *Associate Professor, Department of Computer Science, The University of Hong Kong*
14:45 - 15:00	**Topic: High-performance Modeling of Fabric Deformation** **By Prof. Ka-Wai Kwok** *Associate Professor, Department of Mechanical Engineering, The University of Hong Kong*

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Thought-leadership Series:

AI and Robotics for Garment Industry

24 Feb 2023 (Fri) | HKT (GMT +8) 14:00 – 17:10

In-person at HK Science Park & Online via Zoom | English

15:00 - 15:15	**Topic: High-speed Vision and Projection for Real-world Perception and Augmentation** **By Prof. Shingo Kagami** *Associate Professor, Graduate School of Information Sciences, Tohoku University*
15:15 - 15:35	**Networking Break**
15:35 - 15:50	**Topic: AI & Robotics for Garment Handling** **By Prof. Yasuhisa Hirata** *Professor, Department of Robotics, Tohoku University*
15:50 - 16:05	**Topic: Advanced Mechanisms Design for Robotics** **By Prof. Kenjiro Tadakuma** *Associate Professor, Tough Cyberphysical AI Research Center, Tohoku University*
16:05 - 16:20	**Topic: From Mass Production to Custom Production Using Mobile Robot Transportation** **By Prof. Ranulfo Bezerra** *Assistant Professor, Tough Cyberphysical AI Research Center, Tohoku University*
16:20 - 16:35	**Topic: Mobile Robot Intelligence for Transformable Product Lines** **By Prof. Kazunori Ohno** *Special Appointed Professor, New Industry Creation Hatchery Center (NICHe), Tohoku University*
16:35 - 16:50	**Topic: AI and Robot Control** **By Prof. Kazuhiro Kosuge** *Chair Professor of Robotic Systems, Department of Electrical and Electronic Engineering, The University of Hong Kong* *Director of JC STEM Lab of Robotics for Soft Materials* *Deputy Managing Director of the Centre for Transformative Garment Production* *Life-FIEEE, FJSME, FSICE, FRSJ, FJSAE, Member, Engineering of Academy, Japan*
16:50 – 17:00	**Q&A**
17:00 - 17:10	**Closing Remarks** **By Prof. Kazuhiro Kosuge** *Chair Professor of Robotic Systems, Department of Electrical and Electronic Engineering, The University of Hong Kong* *Director of JC STEM Lab of Robotics for Soft Materials* *Deputy Managing Director of the Centre for Transformative Garment Production* *Life-FIEEE, FJSME, FSICE, FRSJ, FJSAE, Member, Engineering of Academy, Japan*

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ABSTRACTS & SPEAKER PROFILES

Opening Remarks

By Prof. Norman Tien

Managing Director, Centre for Transformative Garment Production

Taikoo Professor of Engineering and Chair Professor of Microsystems Technology, The University of Hong Kong

Speaker biography

Prof. Norman Tien

Professor Norman C. Tien is the Taikoo Professor of Engineering and Chair Professor of Microsystems Technology of the University of Hong Kong (HKU). He is also currently the Head of Innovation Academy of Faculty of Engineering and the Managing Director of the Centre for Transformative Garment Production. He served as the Dean of Engineering from 2012 to 2018, and as the Vice-President and Pro-Vice-Chancellor (Institutional Advancement) (VP(IA)) from 2019 to 2021 at HKU.

Prior to joining HKU, Professor Tien was the Nord Professor of Engineering at Case Western Reserve University, US, where he was the Dean of Engineering from 2007 to 2011. He previously held faculty positions at University of California at Davis, University of California at Berkeley and Cornell University.

Professor Tien received his Ph.D. from the University of California at San Diego, MS from the University of Illinois, and BS from the University of California at Berkeley. His research interests are in the area of micro and nanotechnology, microelectromechanical (MEMS) systems, and robotics.

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Topic: Fabric Modelling

By Prof. Taku Komura

Professor, Department of Computer Science, The University of Hong Kong

Abstract

In this talk, I will present about the techniques that we have developed for accelerating cloth simulation. I will first describe about our project titled Isotropic ARAP Energy Using Cauchy-Green Invariants. In this project, we propose a novel approach for analytic eigenanalysis of isotropic ARAP energy. We also propose a novel analytic solution for decomposing the deformation gradient into the rotation and stretching components. Next, I will present about our novel analytic eigensystem for incremental potential contact, which accelerates the collision detection/response computation for deformable objects. This framework allows the full simulation to run on the GPU, allowing 94x acceleration compared to the original CPU implementation.

Speaker biography

Prof. Taku Komura

Taku Komura joined Hong Kong University in 2020. Before joining HKU, he worked at the University of Edinburgh (2006-2020), City University of Hong Kong (2002-2006) and RIKEN (2000-2002). He received his BSc, MSc and PhD in Information Science from University of Tokyo. His research has focused on data-driven character animation, physically-based character animation, crowd simulation, 3D modelling, cloth animation, anatomy-based modelling and robotics. Recently, his main research interests have been on physically-based animation and the application of machine learning techniques for animation synthesis. He received the Royal Society Industry Fellowship (2014) and the Google AR/VR Research Award (2017).

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Topic: Planning and Learning for Human-Robot Collaboration

By Prof. Jia Pan

Associate Professor, Department of Computer Science, The University of Hong Kong

Abstract

In this talk, we will describe how planning and learning can help human-robot tasks like cloth manipulation and window glazing.

Speaker biography

Prof. Jia Pan

Jia Pan is currently an associate professor in the Department of Computer Science at the University of Hong Kong. He is also a member of the in the Centre for Garment Production Limited at Hong Kong. He received his Ph.D. in Computer Science from the University of North Carolina at Chapel Hill. His research interests are robotics and artificial intelligence as applied to autonomous systems, particularly for developing intelligent algorithms, sensors, and machines to accomplish fully autonomous robots and human-robot collaboration mechanisms.

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Thought-leadership Series:

AI and Robotics for Garment Industry

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Topic: High-Performance Modeling of Fabric Deformation

By Prof. Ka-Wai Kwok

Associate Professor, Department of Mechanical Engineering*, The University of Hong Kong*

Abstract

With technical aids of computational geometry, any morphology of garment fabric, as a continuum structure, could be represented by multiple surfaces comprising numerous triangular meshes which act as the most primitive geometries of any virtual object. Such woven fabric morphological modeling has to comply or interact with the external geometrical constraints, such as the upfront interaction with the human body or even their motion. The meshes representing the cloth are expected to be simulated efficiently to adapt to any morphological change due to the constraints, as well as the dynamic conditions. This work aims to develop a versatile simulation framework for active clothing that can appropriately model various cloth details, including fabric wave, buckling, or wrinkle formation. Such a simulation framework will be a crucial component incorporated into a user interface so as to customize any garment features input by the user. Continued efforts have been devoted to estimating any potential waved winkles/buckling on the fabric. As a result, this estimation can provide real-time guidance to determine the optimal sewing edge or configuration of the fabric and to handle or maneuver the fabric on the robotic sewing platform. This preliminary information, namely the modeled fabric dynamics, will also be beneficial for optimizing the design of any guidance/fixture tools for 2D/3D sewing, thus enhancing the efficiency of the entire sewing process.

Speaker biography

Prof. Ka-Wai Kwok

Dr. Ka-Wai Kwok received the B.Eng. and M.Phil. degrees from Department of Automation and Computer-aided Engineering, The Chinese University of Hong Kong in 2003 and 2005, respectively. He obtained the Ph.D. degree in computing from the Hamlyn Centre for Robotic Surgery, Department of Computing, Imperial College London in 2012. He is currently an Associate Professor at Department of Mechanical Engineering, The University of Hong Kong (HKU). Prior to joining HKU in 2014, he was awarded the Croucher Foundation Fellowship, which supported his research jointly supervised by advisors in The University of Georgia, and Brigham and Women's Hospital, Harvard Medical School. His research interests focus on surgical robotics, intra-operative image processing, and their uses of intelligent systems. He has been involved in various designs of surgical robotic devices and interfaces for endoscopy, stereotactic and intra-cardiac catheter interventions. To date, he has co-authored with over

40 clinical fellows and over 80 engineering scientists. Many of his invention patents (>5) have been licensed or transferred from university to his medical industrial partners in support for their commercialization.

Dr. Kwok's multidisciplinary work has been recognized by various international conference/journal paper awards (>10), e.g. the Best Conference Paper Award in 2018 IEEE International Conference on Robotics and Automation (ICRA). He also became the recipient of the Early Career Awards 2015/16 offered by Research Grants Council (RGC) of Hong Kong, as well as the IROS Toshio Fukuda Young Professional Award in 2020 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), for his contributions to the advancement of MRI-guided robotic systems. He serves as Associate Editor for IROS 2017-20, ICRA 2019-21, Frontier in Robotics and AI, and Annals of Biomedical Engineering (ABME), Proc. IMechE Part I: Journal of Systems & Control Engineering (JSCE) and IEEE Robotics and Automation Magazine (RAM). He is the principal investigator of Group for Interventional Robotic and Imaging Systems (IRIS) at HKU.

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Thought-leadership Series:

AI and Robotics for Garment Industry

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Topic: High-Speed Vision And Projection For Real-World Perception And Augmentation

By Prof. Shingo Kagami

Associate Professor, Graduate School of Information Sciences, Tohoku University

Abstract

In many of robotics applications, it is vital to act timely in response to dynamically changing environments. This talk presents our efforts to enable and apply fast vision processing, partially in conjunction with high-frame-rate low-latency projectors.

Speaker biography

Prof. Shingo Kagami

Shingo KAGAMI received B.E., M.E. and Ph.D. degrees from the University of Tokyo in 1998, 2000, and 2003, respectively. He joined Tohoku University in 2005, where he currently is an Associate Professor.

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Thought-leadership Series:

AI and Robotics for Garment Industry

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Topic: AI & Robotics for Garment Handling

By Prof. Yasuhisa Hirata

Professor, Department of Robotics, Tohoku University

Abstract

Our research goal is to realize flexible cloth handling using robots to automate different tasks in the garment manufacturing industry. This talk introduces robotic hands for garment handling and shows a series of garment handling operations by using dual arms with developed robot hands, such as picking up a T-shirt on a desk and setting it on a board for silk-screen printing.

Speaker biography

Prof. Yasuhisa Hirata

Yasuhisa Hirata is a Professor in the Department of Robotics at Tohoku University, Sendai, Japan. He received his B.E., M.E., and Ph.D. degrees in mechanical engineering from Tohoku University in 1998, 2000, and 2004, respectively. He has been conducting research on Human-Robots Interaction, Multiple Robots Coordination, Factory Automation Robots, etc. He is serving as a project manager of the Moonshot R&D program in Japan. He is also serving as an AdCom member of the IEEE Robotics and Automation Society (RAS), an associate vice-president for the Technical Activity Board of IEEE RAS, and Co-chair of the IEEE RAS Technical Committee on Rehabilitation and Assistive Robotics.

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Thought-leadership Series:

AI and Robotics for Garment Industry

24 Feb 2023 (Fri) | HKT (GMT +8) 14:00 – 17:10

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Topic: Advanced Mechanisms Design for Robotics

By Prof. Kenjiro Tadakuma

Associate Professor, Tough Cyberphysical AI Research Center, Tohoku University

Abstract

Conventional omnidirectional wheel mechanisms are limited in their ability to climb steps and cross gaps. The Omni-Ball, consisting of two connected hemispherical wheels, overcomes these limitations by enabling the crossing of higher obstacles and larger gaps than previously. By elongating the Omni-Ball longitudinally into a cylinder shape, we obtained the Omni-Crawler, which enables omnidirectional mobility on rough terrain. In addition, transforming the cylinder shape into a torus with inner-outer membrane motion not only enables robotic mobility in murky water, but makes it possible to further transition from Omni-Crawler to Omni-Gripper. Conventional soft grippers are not suitable for objects with sharp sections such as broken valves and glass shards, but the torus shape solves this problem by using a three-layered variable stiffness skin-bag made of cut-resistant cloth. A similar function could also be achieved using a string of beads made of titanium which can grip objects of almost any shape, even when they are on fire. Thus, the homeomorphic mechanisms as topological robot mechanism design is shown in this talk.

Speaker biography

Prof. Kenjiro Tadakuma

Kenjiro Tadakuma holds an Associate Professorship at Tohoku University in the field of robotics, where he has been leading the Plus Ultra Mechanism Group since 2015. Throughout his career, he has made outstanding contributions to the design of novel robotic mechanisms. As a Ph.D. student at Tokyo Tech (2004 – 2007), he invented the first omnidirectional mechanism, known as “Omni-Ball”. This brought him to MIT’s Field and Space Robotics laboratory as a post-doctoral researcher (2007), where he went on to contribute to the Mars hopper project and developed a polymer-based mechanical device for medical applications. Back in Japan, he held positions at Tohoku University, the University of Electro-Communications, and Osaka University (2008 – 2015), where he expanded on the concept of omnidirectional mechanisms with successful applications in mobile robotics and gripping mechanisms, such as the “Omni-Crawler” and “Omni-Gripper”. At Tohoku University, he is further aiming to extract the essence of biological mechanisms to express them as robotic mechanisms. Notably, his team won the IEEE ICRA Best Paper Award on Mechanisms and

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Design in 2019. The nature of his inventions illustrates his deep focus in pioneering the field of robotics mechanisms as a fundamental science.

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Thought-leadership Series:

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Topic: From Mass Production to Customizable Production Using Mobile Robot Transportation Systems

By Prof. Ranulfo Bezerra

Assistant Professor, Tough Cyberphysical AI Research Center, Tohoku University

Abstract

Industrial environments that rely on personalized products are characterized by a wide variety of product models and reduced batch sizes, demanding prompt adaptation of resources to a new product model. In such environments, Mass Production methods of industrialization have been proven inefficient. Therefore, a new paradigm of Transformable Production is necessary to work out more flexible and dynamic production lines. In this presentation, we will introduce a vision of Transformable Production using an efficient multi-mobile robot control system.

Speaker biography

Prof. Ranulfo Bezerra

Ranulfo Bezerra is an Assistant Professor in the Tough Cyberphysical AI Research Center at Tohoku University in Sendai, Japan. he received his Ph.D. degree in Information Sciences from Tohoku University, Japan in 2021. He received his M.Sc. and B.Sc. in computer science from the Federal University of Piaui, Brazil, in 2018 and 2016, respectively. His research interests are intelligent robotic systems and robotic perception. A member of RSJ and IEEE.

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Thought-leadership Series:

AI and Robotics for Garment Industry

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Topic: Mobile Robot Intelligence for Transformable Product Lines

By Prof. Kazunori Ohno

Special Appointed Professor, New Industry Creation Hatchery Center (NICHe), Tohoku University

Abstract

We are working on a Transformable product line as a new production method using mobile robots. Compared to the conventional cell production method, this method reduces human resources by replacing all transportation by robots. It allows for the flexible daily increase and decrease of work by interfacing with the control system. However, the flexible daily increase and decrease of work requires frequent partial rearrangements of work locations and changes in the robot's goal points and paths. It is a heavy burden to update the robot map. In this presentation we introduce LayoutSLAM, a new robot map construction method that focuses on the object layouts determined for each work.

Speaker biography

Prof. Kazunori Ohno

Kazunori Ohno is a Special Appointed Professor in New Industry Creation Hatchery Center (NICHe) at Tohoku University in Sendai, Japan (2021-now). He received BS, MS, and Ph.D. from Tsukuba University in 1999, 2001, and 2004. He was a COE researcher at Kobe University in 2004, became an assistant professor and a lecturer at Tohoku University in 2005, and had been an associate professor of NICHe (2012-2021). He was also a PRESTO researcher (2008-2012) and has been a visiting researcher of the RIKEN Center of AIP (2017-2021). His research fields are field robotics, robot intelligence, and cyber-enhanced canines. He established TC on Data Engineering Robotics of RSJ in 2012. He received Kisoi awards in 2008 and 2012, RSJ research awards in 2005 and 2019. A member of RSJ, JSME, VRSJ, JSAE, IEEE.

Co-organizers: HKSTP TransGP JC STEM Lab of Robotics for Soft Materials

Thought-leadership Series:

AI and Robotics for Garment Industry

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Topic: AI and Robot Control

By Prof. Kazuhiro Kosuge

Chair Professor of Robotic Systems, Department of Electrical and Electronic Engineering, The University of Hong Kong

Director of JC STEM Lab of Robotics for Soft Materials

Deputy Managing Director of the Centre for Transformative Garment Production

Life-FIEEE, FJSME, FSICE, FRSJ, FJSAE, Member, Engineering of Academy, Japan

Abstract

There are many expectations about AI and robots replacing humans. While AI cannot provide a complete solution, AI is a valuable tool for applying robotics technology to real-world challenges that cannot be solved by traditional methods. In this presentation, we will consider how recent AI and machine learning techniques can be applied to robot control problems for real-world challenges, using several examples developed by my research team.

Speaker biography

Prof. Kazuhiro Kosuge

Professor Kazuhiro Kosuge is the Deputy Managing Director of TrasnGP, Director of JC STEM Lab of Robotics for Soft Materials, and a Chair Professor of Robotic Systems at the University of Hong Kong.

He joined Tohoku University and served as a Professor, Department of Machine Intelligence and Systems Engineering from 1995 to 2003, a Professor, Department of Bioengineering and Robotics from 2003 to 2016, and a Professor, Department of Robotics from 2016 to 2021. From 2018 to 2021, he was a Tohoku University Distinguished Professor. For more than 39 years, he has been conducting research on robotics and its applications in the real world. He has published over 390 technical papers. Over 70 of his patents have been transferred to the industry.

He served as 2020 IEEE Vice President for Technical Activities, 2015-2016 IEEE Division X Director, and 2010-2011 President of IEEE Robotics and Automation Society. Honours include the Medal of Honor with purple ribbon in 2018 in the name of the Emperor of Japan, and the 2021 IEEE RAS George Saridis Leadership Award in Robotics and Automation. He is a Life Fellow of IEEE and a member of the Engineering Academy of Japan.