Session on

Digital Twin Diverse Industrial Applications (DIA)

Tuesday, October 16th 2024

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Milan Time	Beijing Time	Agendas
15:00	21:00	**DIA-1** Enhancing Worker Health and Safety in Construction Through Motion Capture Systems: Insights from Industry 5.0 Md Hadisur RAHMAN
15:30	21:30	**DIA-2** Digital Twins as Key Technology in Sustainable Manufacturing, Robotics and Space Applications Benjamin SCHLEICH
16:00	22:00	**DIA-3** Industrial AI-enabled Smart Manufacturing: Methods and Applications Dazhong WU
16:30	22:30	**DIA-4** Leveraging Large Language Models for Humanoid Cognition in Proactive Human-Robot Collaboration Shufei LI
17:00	23:00	**DIA-5** Changeable production systems for circular manufacturing by utilizing digital twins Merlin KORTH
17:30	23:30	**DIA-6** Unlocking the Potentials of a Service-Oriented Architecture in Production Planning and Control Sebastian BEHRENDT

Digital Twin Diverse Industrial Applications (DIA)

Chair

Li YI

Associate Professor (Dr.-Ing.)

Beihang University (China)

Co-Chair

Matthias KLAR

Senior Research Fellow (Dr.-Ing.),

University of Kaiserslautern-Landau (Germany)

DT Diverse Industrial Applications (DIA-1)

Md Hadisur Rahman

Graduate Research Assistant (M.S.),
West Virginia University (US)

Title:

Enhancing Worker Health and Safety in Construction Through Motion Capture Systems: Insights from Industry 5.0

Abstract

Industry 5.0 emphasizes the collaboration between humans and intelligent systems, driving technological advancements across various sectors. In this context, Motion Capture (MoCap) technology plays a crucial role in enhancing worker health and safety in the construction industry by seamlessly integrating with these intelligent systems. The study analyzed 52 studies from the Scopus database, demonstrating the effectiveness of MoCap technology in reducing work-related musculoskeletal disorders and occupational hazards. The research revealed that marker less systems and wearable IMU sensors are widely used in construction. Finally, the study contributes to the body of knowledge on how MoCap technology ensures construction safety and offers suggestions for future research directions in line with Industry 5.0 principles.

DT Diverse Industrial Applications (DIA-2)

Benjamin Schleich

Professor (Dr.-Ing.),
Technical University of Darmstadt (Germany)

Title:

Digital Twins as Key Technology in Sustainable Manufacturing, Robotics and Space Applications

Abstract

The digital twin as a virtual representation of physical assets offers immense potentials for new business models and product-service-systems. Considering these benefits, the presentation will dive into the technological fundamentals of digital twins and will highlight state-of-the-art applications of digital twins in sustainable manufacturing, robotics, and space technology. Specifically, it will be shown how sustainability data models support the design of digital twins for CO2-efficient manufacturing and how digital process twins may support the realization of in-orbit small satellite factories. Beside this, future research directions are carved out.

DT Diverse Industrial Applications (DIA-3)

Dazhong Wu

Associate Professor (PhD),
University of Central Florida（US）

Title:

Industrial AI-enabled Smart Manufacturing: Methods and Applications

Abstract

Despite the broad range of applications for artificial intelligence (AI) in tasks such as image recognition and natural language processing, there are still challenges to implementing AI in the manufacturing industry. One of the main obstacles is the difficulty in integrating prior knowledge into machine learning to provide explanations for the decisions made by AI systems, as well as the challenge of ensuring that AI models can be generalized to different manufacturing settings. This presentation will explore the use of deep learning, physics-informed machine learning, and transfer learning in the context of manufacturing and the mechanics of additively manufactured materials. Specifically, it will showcase a deep learning model that predicts the temperature of the melt pool during a directed energy deposition process, a physics-informed machine learning model that incorporates the physics of the chemical mechanical planarization process, and a novel transfer learning framework that can predict the complex mechanical behavior of additively manufactured composites and lattice structures.

DT Diverse Industrial Applications (DIA-4)

Shufei Li

Postdoctoral Research Fellow (PhD),
Nanyang Technological University (Singapore)

Title:

Leveraging Large Language Models for Humanoid Cognition in Proactive Human-Robot Collaboration

Abstract

Proactive Human-Robot Collaboration (HRC) aims for mutual-cognitive, predictable, and self-organizing teamwork between humans and robots, vital for human-centric smart manufacturing. To enable Proactive HRC, methods such as deep neural networks for visual detection, scene graphs for decision-making, and reinforcement learning for robot execution have been explored. However, these methods often need re-training with domain-specific datasets, limiting their generalizability. Large Language Model (LLM) technology offers a solution for understanding tasks, modeling human intentions, and planning robot actions using vision-language instructions. This paper explores humanoid cognition in Proactive HRC, evaluating LLM methods for task explainability, human-centricity, and robot executability, and discusses future integration prospects in manufacturing.

DT Diverse Industrial Applications (DIA-5)

Merlin Korth

Research Associate,
Karlsruhe Institute of Technology (Germany)

Title:

Changeable production systems for circular manufacturing by utilizing digital twins

Abstract

High Volume manufacturing is characterized by the need to control a stable manufacturing system, often in form of a semi-automated system, and, thus, provides an ideal testbed for the implementation of digital twins in a brownfield environment. The proposed approach aligns a manual crafted digital twin event discrete simulation over a long term with the real system behavior. Therefore, both automated stations, their respective behavior as well as humans in the manufacturing system are considered. The validation in a large real-world system shows the ability to control deviation between the digital twin and reality in an acceptably narrow band.

DT Diverse Industrial Applications (DIA-6)

Sebastian Behrendt

Research Associate,
Karlsruhe Institute of Technology (Germany)

Title:

Unlocking the Potentials of a Service-Oriented Architecture in Production Planning and Control

Abstract

The trends of shorter product lifecycles and volatile market environments require manufacturers to operate their productions efficiently to maintain their competitiveness and customer satisfaction. Industrie4.0 opened up the potential to use data of a digitized production system to analyze it, understand it and improve it with suitable mining and optimization algorithms. Although such algorithms exist, their application is often limited in practice because their use is mostly manual and requires expertise. This keynote shows how to resolve this limitation and make production planning and control (PPC) more automated and integrated by utilizing service-oriented architecture.