Robotics is spearheading Smart Production – but we need to deliver, too

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Robot simulation and robot control

*sigh* ... my first “digital twin”
Overview

Technologies
From robot control and simulation
to “digital twins” and Smart Production

Transfer, trust and agility
Trying harder to bridge the gap between academia and industry
Technologies
System components
Robot simulation, monitoring and control
Simulation-based system development
Mockup for optimization of approach trajectories for DLR
System components

...plus sensor simulation and MAS control
Simulation-based system development
R&D and operator training for the state of North-Rhine Westfalia (NRW)
System components

DB technologies and VR to pull in, manage and visualize large environments

- Virtual Reality
- Database technologies
- Robot simulation
- Sensor simulation
- Ethernet communication
- Robot control
- Multi agent system control
Simulation-based system development
Virtual commissioning for micro-optical assembly stations
Smart Production in context
IoT shapes “Smart X”

Source: Bosch Rexroth 2016
Breaking existing hierarchies
Smart Production redefines horizontal and vertical integration schemes

Source: Plattform Industrie 4.0 2016
Data-oriented view on digital twins
aka “Administrative shell”
Production-oriented view on digital twins

Optimization potentials based on digital twins
System-oriented view on digital twins
resp. digital twins in robotics

Virtual system

Physical system

Environment

System

Databases (a-priori & in-situ)

Target environment

Target system

Process

Inputs

Outputs

Simulation & Planning

Outputs

Target environment

Target system

Process

Inputs

Outputs

Exteroceptive sensor data

Proprioceptive sensor data
Optimization of equipment poses

e.g. camera and robot positioning in ReconCell
Optimization of layup strategies

Piston motion patterns in FlexCell
Details on our approach in FlexCell

Ole W. Nielsen, Christian Schlette and Henrik G. Petersen:
*Fast and Simple Model for Free Hanging, Pre-impregnated Carbon Fibre Material*
Simulation of other automated components

e.g. vibratory bowl feeders
NEW: Human-robot collaboration

e.g. assembly of injection molds for LEGO
Transfer, trust and agility
I4.0-Lab and I4.0-LS
Our complementary I4.0 initiatives for different audiences

Industry 4.0 Laboratory (I4.0-Lab)
- Started spring 2018
- SDU funding >100 Mio. DKK
- Focus on factory automation

Smart Production of Large Structures (I4.0-LS)
- Expected start late 2018
- SDU funding to be announced
- Focus on large structures

SDU I4.0 approach
- Shared engineering methodology
- Shared technological backbone
- Shared results and solutions
I4.0-Lab and I4.0-LS
Our initiative to start a “reactor” with companies

- Center program
  - SDU & collaborators
  - Facilities
  - Education
  - Research
  - Administration

- Membership program
  - Companies & SDU
  - Automation
  - Construction
  - Maritime

SDU I4.0 approach
- Shared engineering methodology
- Shared technological backbone
- Shared results and solutions

Public funding

Private funding
We need to improve - trust and agility

- Realistic results and outcomes
- Continuous, reliable partnerships
- Rapid and robust developments
- Clear IPR management
- Clear administrative processes
- Short response times
Thank your for your attention

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