

How Al Can Help in Human-Robot Collaboration

VETENSKAP

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Presentation Outline

Past: A Brief History of AI

Present: Human Centricity in Assembly

- Human-Robot Collaboration
- Brain Robotics

Future: Research Directions



Reference

[Extended from] L. Wang, "From Intelligence Science to Intelligent Manufacturing," *Engineering*, Vol.5, No.4, pp.615-618, 2019.







Garry Kasparov playing Deep Blue in 1997



Honda ASIMO walking downstairs in 2005



DeepMind Servers in USA ®KBA Google DeepMind 🙆 AlphaGo Challenge Match

AlphaGo vs. Lee Sedol

AlphaGo in 2016

During the legendary matches:

- Google cloud servers in the USA using 1920 CPUs, 280 GPUs and 64 search threads.
- Big data: 30 million moves.
- Reinforcement leaning, Monte Carlo search combined with deep neural network for decision making.



Self-Learning of AlphaGo Zero in 2017













Text-to-Video by Sora in 2024





AI for Smart Manufacturing





Human-Robot Collaboration





Active Collision Avoidance



Reference Schmidt B, Wang L (2014) Depth camera based collision avoidance via active robot control. *J Manuf Syst* 33(4):711–7118.



Deep Learning of Assembly Context



Wang P, Liu H, Wang L, Gao RX (2018) Deep learning-based human motion recognition for predictive context-aware human-robot collaboration. *CIRP Ann - Manuf Technol* 67(1):17–20.

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Reference









Concept of Brain Robotics



Reference

L. Wang, S. Liu, C. Cooper, X. V. Wang and R. X. Gao, "Function Block-Based Human-Robot Collaborative Assembly Driven by Brainwaves," *CIRP Annals – Manufacturing Technology*, Vol.70, No.1, pp.5-8, 2021.



From Brainwaves to Control Commands



Base wavelet selection: according to the mean values of energy-to-entropy ratio of B-Spline (80), Bump (66), Morlet (172), Morse (130) and Shannon (149), Morlet is chosen in this research.

Reference

L. Wang, S. Liu, C. Cooper, X. V. Wang and R. X. Gao, "Function Block-Based Human-Robot Collaborative Assembly Driven by Brainwaves," *CIRP Annals – Manufacturing Technology*, Vol.70, No.1, pp.5-8, 2021.



Macro-Micro Robot Control by FBs



Reference Wang L, Schmidt B, Givehchi M, Adamson G (2015) Robotic assembly planning and control with enhanced adaptability through function blocks. *Int J Adv Manuf Technol* 77(1–4):705–715.



Stimulus-free Brainwave-driven HRC Assembly







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New Definition: ChatGPT + Robot = Figure 01

- With OpenAI, Figure 01 can now have full conversations with people.
- OpenAI models provide high-level visual and language intelligence.
- Figure neural networks deliver fast, low-level, dexterous robot actions.
- Figure 01 robot can describe its visual experience, plan future actions, reflect on its memory, and explain its reasoning verbally.



References

https://spectrum.ieee.org/figure-humanoid-robot

https://spectrum.ieee.org/video-friday-2-6-billion?utm_campaign=post-teaser&utm_content=vh1zf9al



Peeking into a Factory in 2050





Or Manufacturing as a Fantasy









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