

HUMAN-CENTERED ROBOTIC AUGMENTATION

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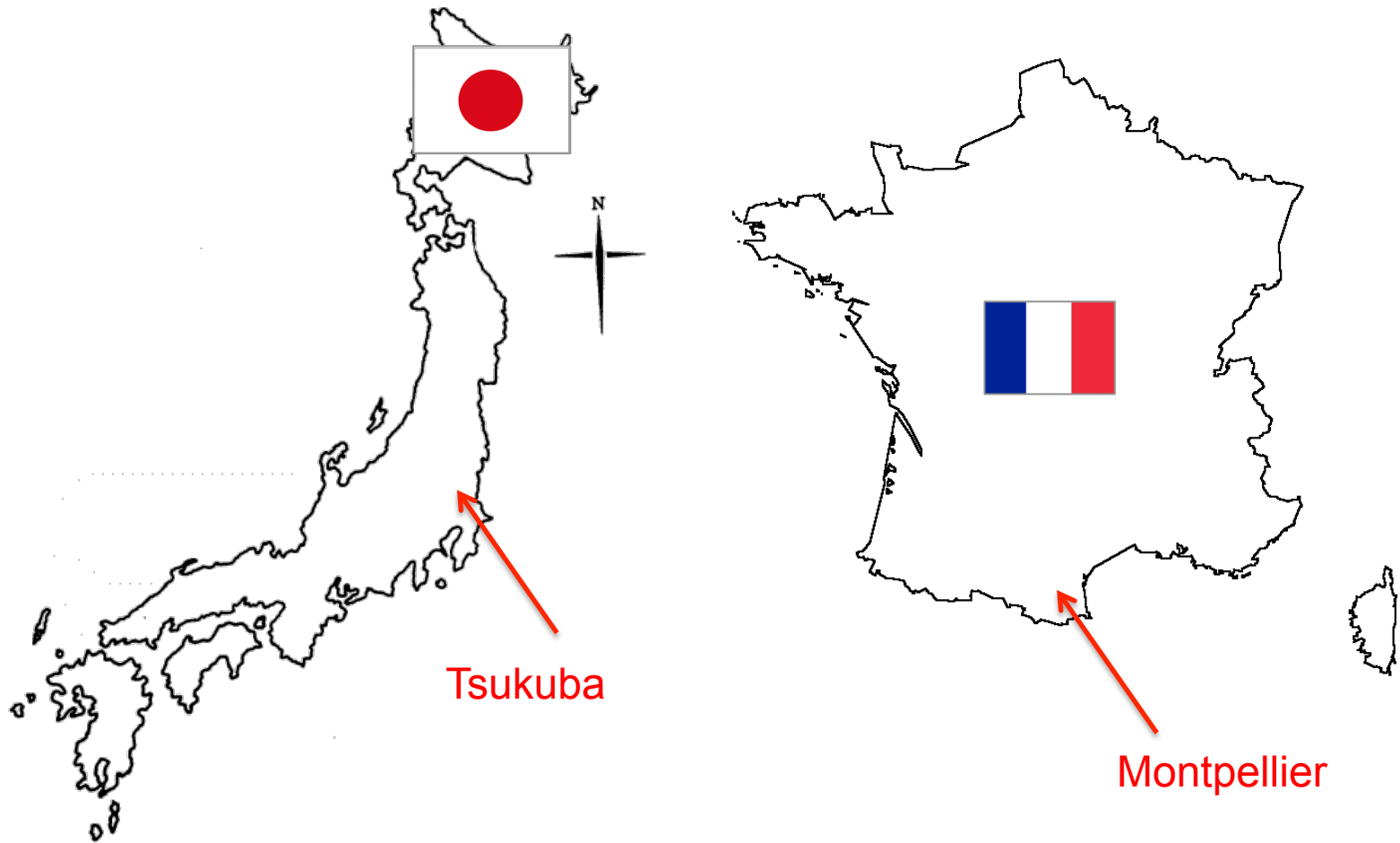
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Labs

- CNRS-AIST JRL and CNRS-UM2 LIRMM - IDH



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What are we talking about?

- The quest for human augmentation or substitution?
- Enhancing intellectual capabilities
 - Mathematics, computers (toward wearable) and software, chemical, etc.
- Enhancing perceptual capabilities
 - Night vision systems, access to third parties thought, etc.
- Enhancing physical capabilities
 - Different tools, machines, vehicles, chemicals, etc.
- Robotics and AI
 - Gathers almost all three in one system!



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Robotics and computers

- Similar historical pathways toward common
- Computers

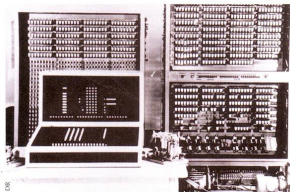
– Zuse 3/ENIAC (1941) <> UNIMATE (1950)

– Personal computer

- Programma 101 (Olivetti) 1962

– >>> personal robots (?)

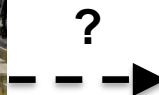
- Robotic boomerang story



Automation production line



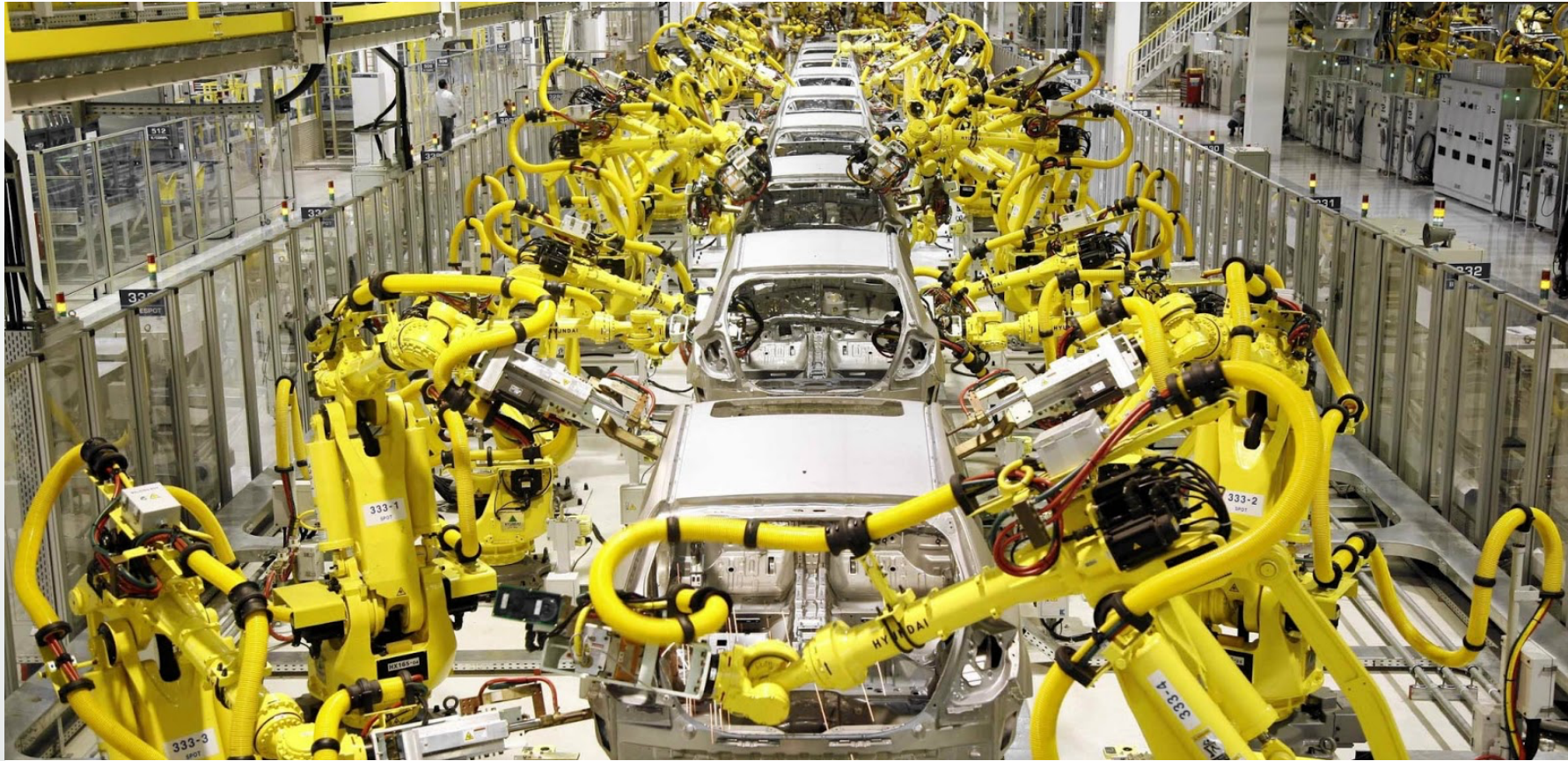
Cobotic production line



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Before (and even now)



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Artificial intelligence and robotics?

- History
 - Shakey



- Recent trends



Intelligence: what does it mean?

- Intelligence?
 - I do not know what it means from an engineering and biological perspective, so...
- Artificial intelligence
 - ...I do not know what it's artificial counter-part means
 - But it shares a common ground with **big data**

"...everyone talks about it, nobody really knows how to do it, everyone thinks everyone else is doing it, so everyone claims they are doing it."

Dr Dan Ariely, Duke University

- So?
 - I banned this term from my research objectives, papers and team's language 😊



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Human-centered robotics

- Service robotics engendered
 - Sharing the space with human
 - Creation of multiple type of service robotics that are service-customized
- Nowadays...
 - Robotic systems are centered on human
 - Other requirements, another design philosophy...
 - E.g. integration of haptics and touch
- Reintegrating the industry with novel production line view
 - Robots are human workers partners: “cobots”
 - Possibly having highly dynamic and flexible lines (e.g. SME)



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Robotic augmentation

- What?
 - Physical capabilities
- Why?
 - Getting round of an handicap, ageing, quest for power...
- Taxonomies based on human-robot “distance”
- Robots distant from human
 - Drones, mules, minesweeper...
- Robots in close-contact with human
 - Vehicles, exoskeletons, human extenders...
- Robots within human bodies
 - Medical robotics (artificial organs –e.g CARMA, nanorobots)



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Control strategies

- In function of the human-robot “distance”
- Specific interfaces
- Robots distance > 0
 - Well established and mastered
 - Teleoperation/telepresence modes, shared autonomy...
 - Network transmission delay problem
- Robots distance $= 0$
 - Some approaches proved to be efficient
 - Safety, transparency, apparent inertia, human-contact, embedded power...
- Robots distance < 0
 - Medical applications mainly
 - Specific functionalities, autonomous mode



Exoskeleton case

- A bad “good-idea”
 - Rehabilitation OK
 - Other applications (e.g. infantryman)
 - Should be consumed with moderation
- Nature has its laws
 - Physics fixes the game rules
 - Allometry
 - How many living being has exoskeletons?
 - The biggest known is the coconut (or robber) crab *birgus latro*
 - Nature and biology scientists claim that is impossible with the current law of physics to have bigger living species with exoskeleton
 - Yet roboticists are keep trying 😊

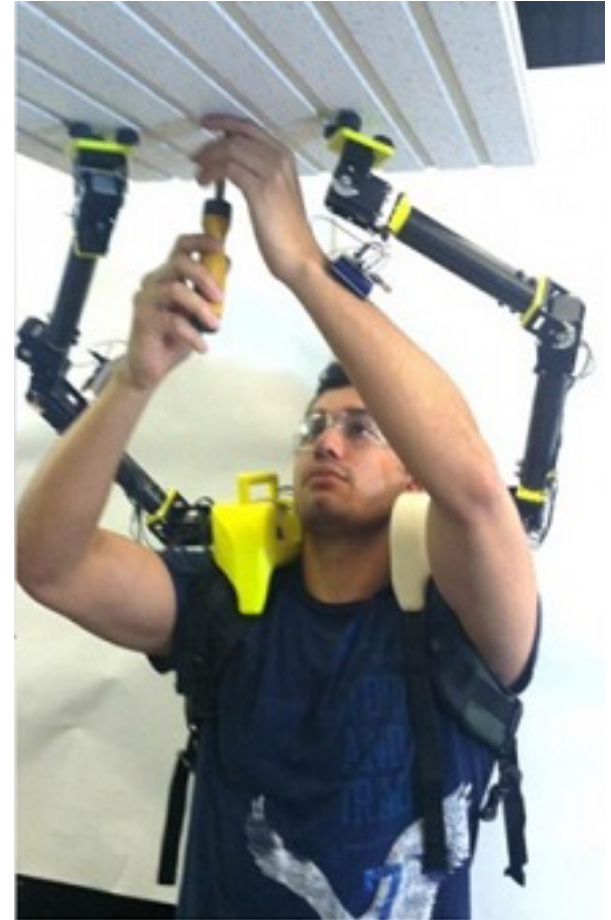


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Supernumerary links

- Supernumerary-fingers
- Extra-arms
 - Solution envisioned by Boeing
 - The idea is to “wear” a robotic system to increase number of limbs and strength
- Problem
 - Control interface
 - Thought-based control?



Courtesy of H. Asada, MIT

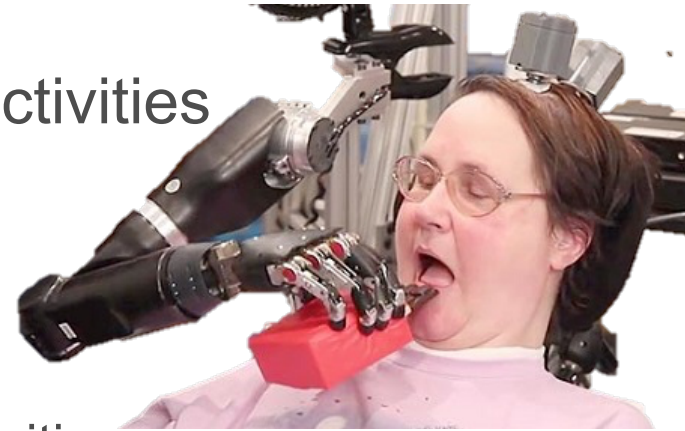


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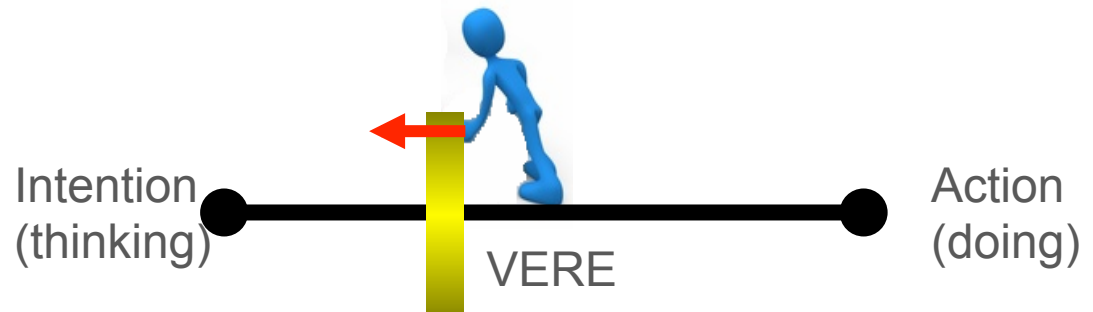
Thought-based control

- It's more of a laboratory "product" than reality
- Neuro-feedback is very limited
- Limited patterns of brain signal activities
- Current trends (successful)
 - Trajectory-based control
- What alternative?
 - Guess the intentions from brain activities and physiological signals related to task affordance (object affordance)
- Mind-controlled robot
 - Several benefits if latencies can be reduced and brain patterns better identified

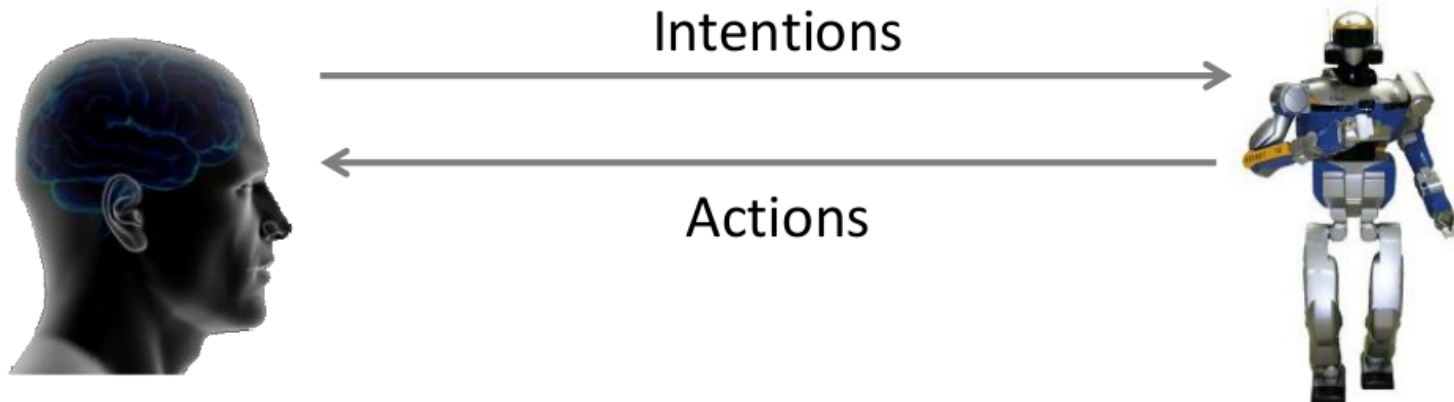
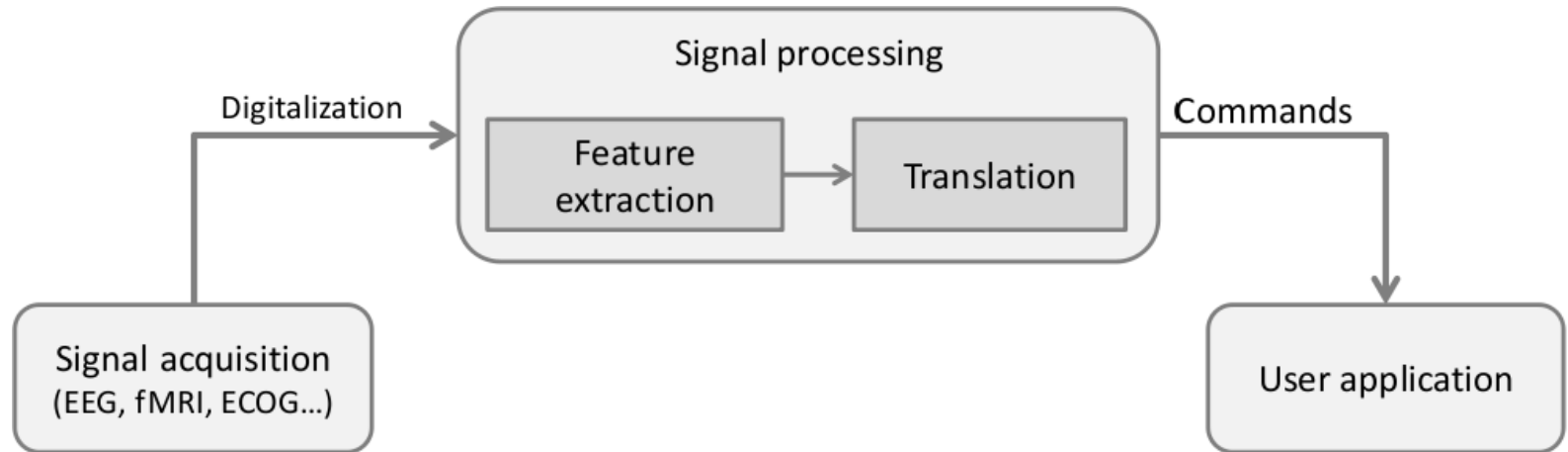


Humanoid physical embodiment BCI

- Objective (EU project VERE) www.vereproject.eu
 - Human incarnation in another body (humanoid robots)
- Scientific issues
 - Body possession: what does my body means (neuroscience)
 - Intention recognition (brain waves signal processing)
 - Sensory-based embodiment (physiological signal processing)
 - Embodiment and consciousness (ethics, philosophy)
 - Human-robot interaction, robotic surrogates (robotics)



Principle (intention-driven control)



Gergondet, Kheddar, IEEE LSGCC 2013



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Mind controlled humanoid



Gergondet, Kheddar, Hintermuller, Guger, Slater, ISER 2012

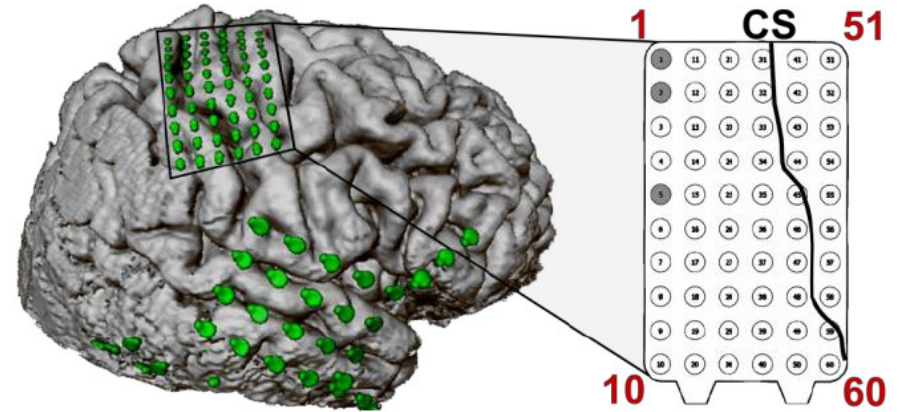


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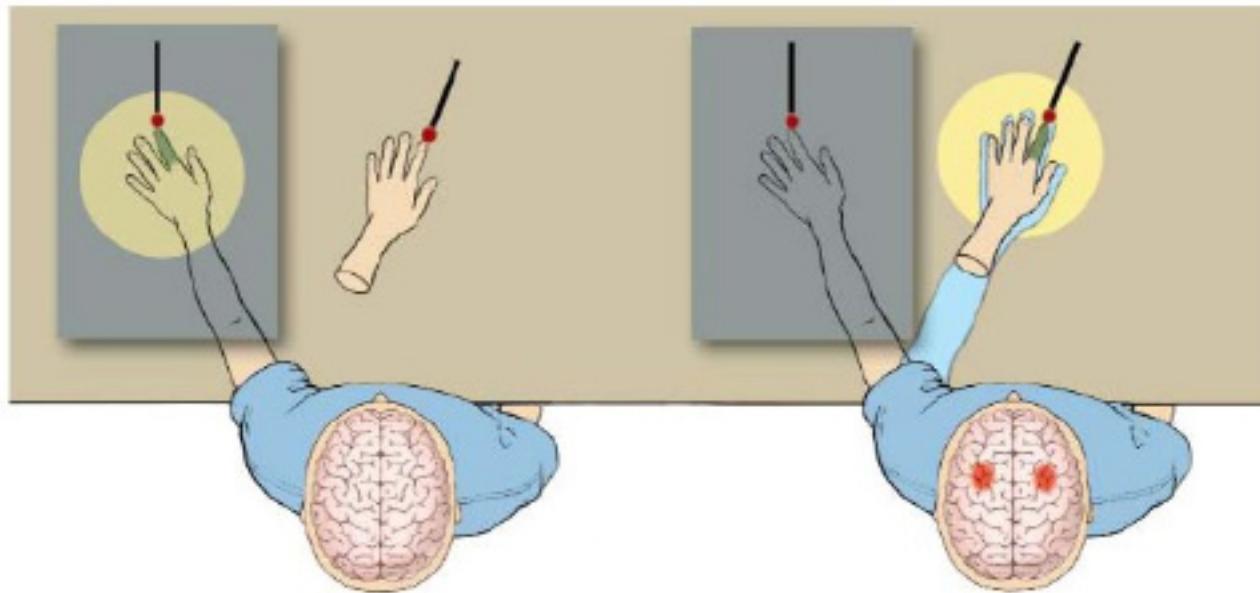
Embodiment understanding

- Patients implanted with ECoG
 - Prof. Kamada, Neurosurgery Dpt. Asahikawa MD HP
- Using humanoid robot avatar
- Contribution to the understanding of
 - What self means
 - Consciousness
 - How pertinent is thought-based control of complex systems
 - Brain functions



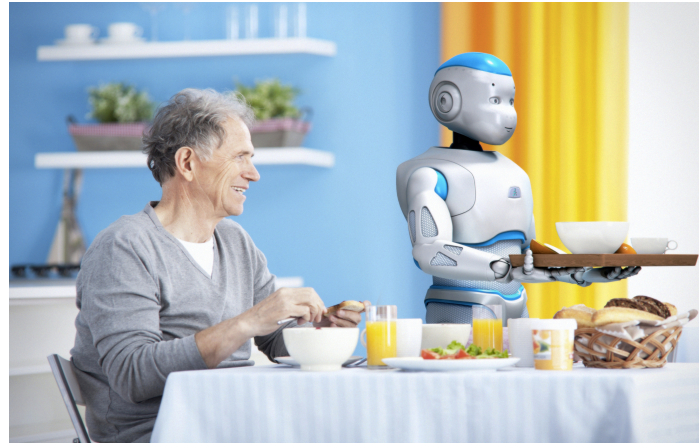
Embodiment

- It is not enough to have a reliable human-centric technology
- Trust in its usage is important
- Embodiment is a lowly know concept in robotics
 - Beyond telepresence



Service humanoids and domotics

- Aldebaran's ROMEO 2 project vision



- RoboHow.Cog's Vision



Web-enabled and Experience-based
Cognitive Robots that Learn Complex
Everyday Manipulation Tasks



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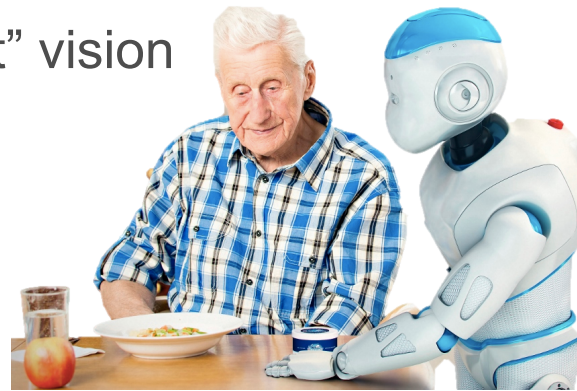
Vision of future “Smart houses”

- A smart house or a house with a smart integrated robot?

- Smart house automation
a “distributed robot” vision



- House with a smart robot
an “integrated robot” vision

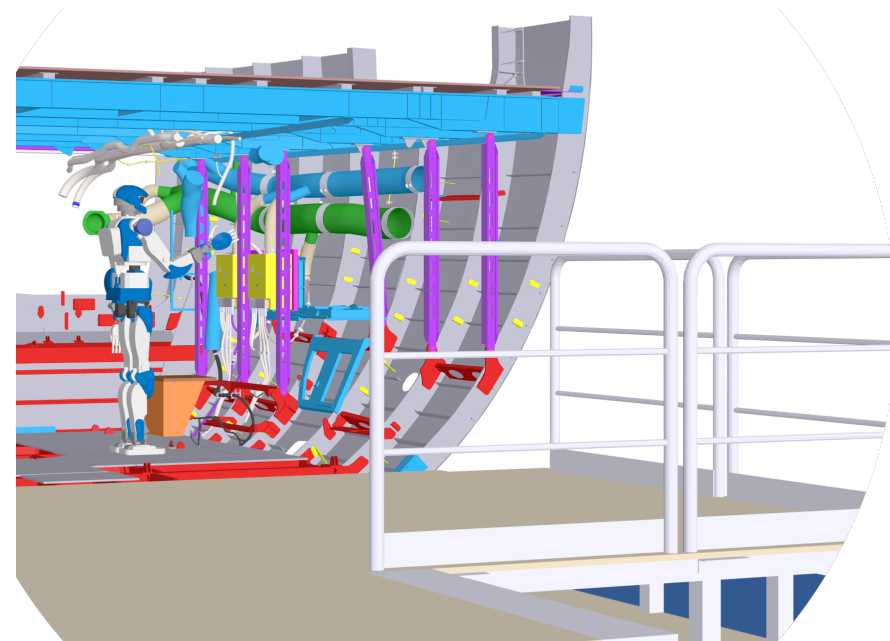


- The “smart house” is likely a mix of the two visions



Manufacturing humanoid robots

- Inner-product automation
 - Aircraft manufacturing
 - Shipyards and building construction
- COMANOID Project (with Airbus Group)
 - Multi-contact Collaborative Humanoids in Aircraft Manufacturing www.comanoid.eu



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Today (Glory factory in Saitama, Japan)

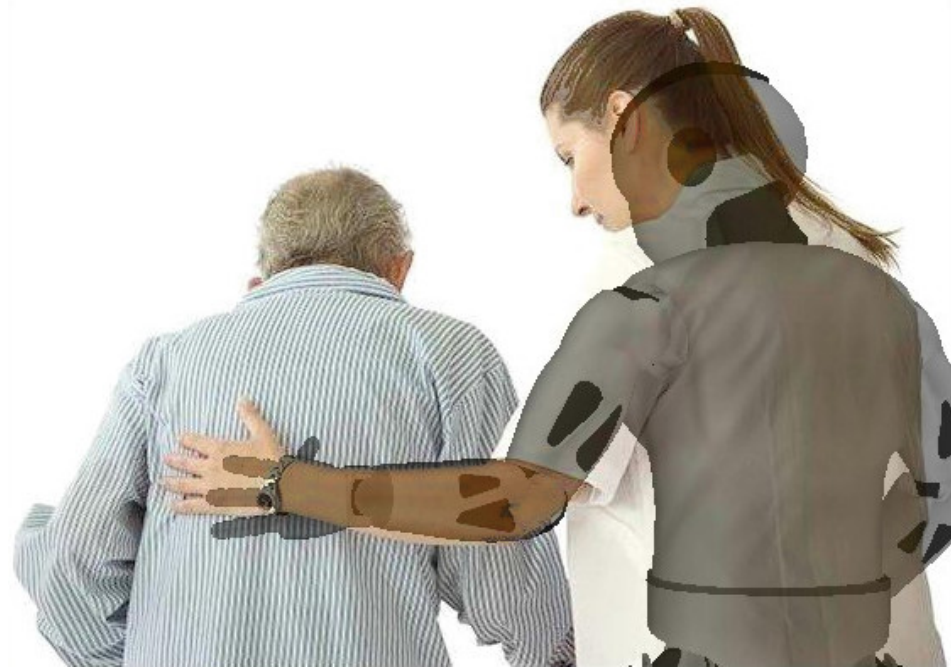
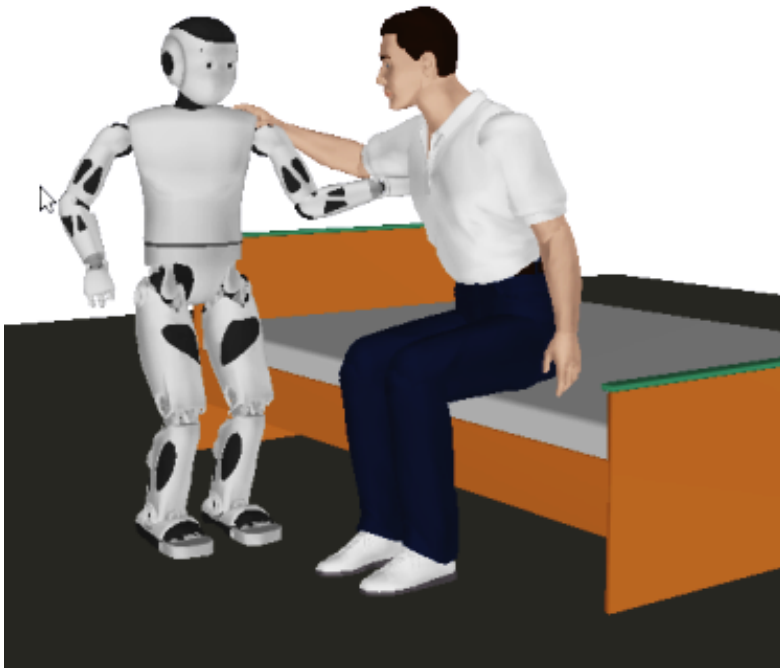


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Humanoid for frail persons assistance

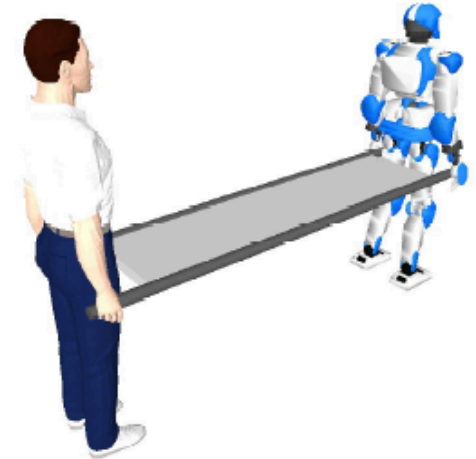
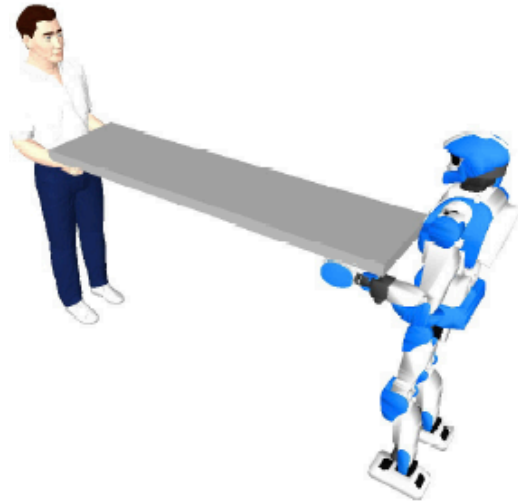
<http://www.projetromeo.com> with ALDEBARAN SoftBank



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Collaborative humanoid robots



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Visuo-haptic cues

Université Montpellier 2-CNRS LIRMM
CNRS-AIST Joint Robotics Laboratory UMI3218/CRT

Carrying a free-moving ball on a table by human-humanoid dyad using vision and haptic sensing

Don Joven Agravante
Andrea Cherubini
Antoine Bussy
Pierre Gergondet
Abderrahmane Kheddar



D-J. Agravante, Cherubini, Bussy, Gergondet, Kheddar, ICRA 2014

Conclusion

- Robotic systems will become part of the new ICT era
 - Expect changes in culture, society and work practices
 - Ethical and legal issues are being investigated
- To be seen as the missing component of ICT
 - Remote “action” physical changes at a distance
- Robotic systems are nowadays human-centered
 - New challenge in the design, safety and perception, understanding (human-robotic systems relation-ship)
 - Robotic-human distance = 0
 - Complex
 - Breakthrough expected in the hardware and software
- What is a “physical augmented human” finally?
 - A human with more sophisticated tools

