Anthropomatics
What can robots learn from humans and vice versa

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Anthropomatics

Science of the Symbiosis between Humans and Machines
Strategic Goal and Mission

- Design, implement and evaluate highly usable and acceptable humanoid systems to improve human’s quality of live

- Humanoid robot systems that coexist with humans as assistants and companions at different ages, situations, activities and environments

- Robot systems for augmenting human capabilities (speech translation, prosthesis, telepresence, ...)

- Core technologies (sensors, actuators, embedded systems, ...) for human-centred application

- Robot technologies for manufacturing and production

- Cognitive information processing in technical systems
Current research activities at KIT

- Analysis of Human Motion
- Interactive Learning
- Programming by Demonstration
- Telepresence
- Embedded Systems
- Mechanical Construction

Learning

Multimodal Interaction

Speech, Gesture and Mimic

Tactile Interaction

Human-Robot Interaction

Learning

Mechatronics and Motor Control
Limitations and shortcuts

- Systems are designed for “sunshine” environments with limited scope and simple tasks.

- The transferability of the developed skills and abilities to varying contexts and tasks without costly redesign of specific solutions is still impossible:
  - How to define measurable and scalable challenges in an open scenario under changing conditions,
  - How to define metrics and benchmarks that highlight and focus on transferability rather than performance
  - How to define frameworks and representations which allow for learning of new skills, adapting already acquired skills, for switching between different learning modalities or combining multiple forms of learning.
  - Representational differences between high-level AI planning and low-level robotics/vision
Long-term goals

- Humanoids as companions and assistants for citizens in different ages, situations, activities and environments in order to improve the quality of life

- Knowledge representation and sharing across distance, time and cultures

- Internet of skills: Skill learning and skill transfer between different embodiments

- Interoperability: Common/shared complex platforms with standard/common/open-software

- Understanding cognitive information processing
Humanoids als universal Interfaces

Separated by language, culture, time, constraints …

Humanoids as mediators across time, distance, disabilities, cultures and societies

Internet
Intelligent environment
Network
Agents
Humanoids als universal Interfaces

...and distance

Humanoids as mediators across time, distance, disabilities, cultures and societies

Internet
Intelligent environment
Network
Agents
Humanoids as universal interface

Acoustic

visual

haptics

Haptics

Emotional

Emotional

Fully linked

Internet

Intelligent environments

Networks

Agents
Challenges

- **Globalization**
  Overcoming language and cultural differences

- **Resources shortage**
  Overcoming of distances

- **Population aging**
  Independent live despite physical and mental limitations
Challenges

Humans increasing dependency on technology

Bottlenecks in human communication and interaction
Mediation through humanoids

- Conceptualization of the process which transfers multimodal information, such as facts, knowledge, skills, content, meaning, and behavior across different embodiments, i.e., from humans driven by neural representations to machines characterized by physical and digital information.

- Transfer mechanism should preserve the originally intended meaning and modalities of the sender’s message and will be generated at the receiver’s side such that the original message can be perceived by humans with all senses.
Concept of Mediation

Feedback

Speech
Motion
Haptics
Inner state
Vision

Semantic Representation
Knowledge
Intention
Meaning
Content

Extraction

Expansion

Speech
Motion
Haptics
Inner state
Vision
Fundamentals of humanoid mediation

**Naturalness**

**Multimodale Interaction**
- Speech
  - Speech recognition and translation
- Haptics
  - Artificial skin
  - Haptic interfaces
- Telepresence
  - Teleoperation
- Biosignals
  - EMG based Protheses
  - Emotion recognition
- Image processing
  - Smart Room
  - Image data fusion

**Universalness**

**Humanoid Robots**
- Platform
- Architecture
- Demonstrators

**Adaptivity**

**Scientific fundamentals**
- Learning
- Representations
- Knowledge transfer
- Machine Intelligence
- Programming by demonstration
- Systematic system design
- Planning und control
**Humanoid Mediation**

**Funktional Mediation**
- Augmentation of human’s functional capabilities
  - Telepresence
  - Grasping
  - Manipulation
  - Haptics

**Scientific Fundaments**
- Learning
- Representations
- Knowledge transfer
- Machine Intelligence

**Social Mediation**
- Machine-aided human-human communication
- Speech
- Empathy
- Body language
- Culture and Ethics

**Humanoids**
- Platforms
- Architecture
- Demonstrators
Hello Kobian,
I would like to invite friends for dinner tonight.
I would like to prepare Sushi for them. Can you help me?
Hello Kobian!
Prof. Dillmann and Prof. Waibel will be over for dinner tonight.
I would like to prepare Sushi for them. Can you help me?

こんにちは、コービアン！
今夜のディナーにディルマン先生とワイベル先生が来ます。
私は彼らに寿司を用意したい。手伝ってくれますか？
はい、わかりました。お寿司を作るには、お米とお酢、魚、海苔、そして醤油が必要です。
はい、わかりました。
お寿司を作るには、お米とお酢、魚、海苔、そして醤油が必要です。

Yes, I understand.
You need vinegar, rice, fish, nori and soy sauce to make it.
Okay. But I don't know what nori is.
O.k., but I don't know what nori is.

わかりました。でも、私は海苔が何か知りません。
海苔は海藻の一種を紙のように薄く加工したものです。これでご飯を巻いて食べます。
Nori is a kind of seaweed and it looks like paper. We eat rice by wrapping it in nori.
Humanoid mediators

Humanoids from different cultures will serve as mediators to transfer skills and task knowledge across distance and cultural barriers.

- **Human → Robot**
  - Imitation learning and Programming by Demonstration
  - Skill and task knowledge learning from observation
  - Verbal-based advice and explanation to help the robot to categorize its sensorimotor experience

- **Robot → Robot**
  - Interoperability between robots (human/mediators) → Middleware
  - Supervised skill and task learning in teleoperative manipulation tasks
  - Robot learn from little experience and/or use the experience and knowledge of other robots to learn new capabilities faster

- **Robot → Human**
  - Humanoids teach humans new skills and tasks through demonstration (e.g. a European user learns to prepare Sushi based on knowledge provided by a Japanese Sushi chef).
Thanks for your attention