

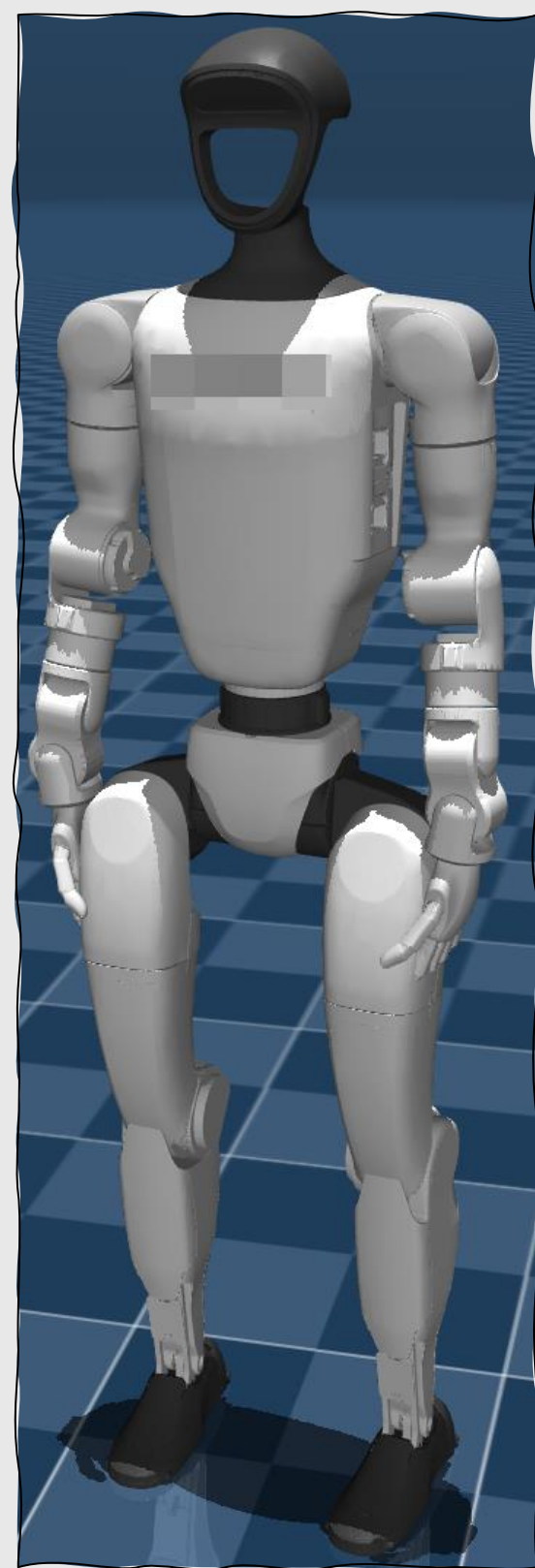
Humanoid Robots: Challenges for Occupational Safety and Health

Several hundreds of humanoid robots are expected to populate factory floors in Germany within the next five to ten years even considering conservative market forecasts. Here, challenges with regards to the safety of such systems may not be neglected.

Humanoid Robots at a Glance

Concerning the definition

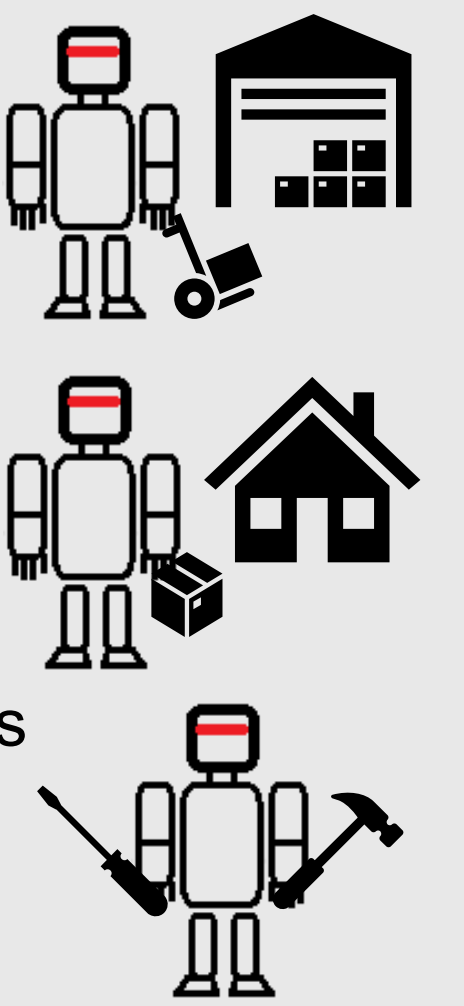
- Lack of a clear definition
- **“Human like“ appearance and behaviour**
- No clear features:
 - One head?
 - Two arm?
 - Two hands with five fingers?
 - Two legs?
 - Communication with persons?
 - Physical interaction with persons?
- “Humanoid robot” even without some of those features



\$	13.500 USD
⚖	35 kg
📏	130 cm
🏎	7,2 km/h
🏋	2 kg
💪	120 Nm (max.)
🔋	2 hours

Aims and Applications of Humanoid Robots

- Manufacturers aim to **support or replace human work**:
 - Increase efficiency and productivity
 - Address shortage of labour
 - Take over dangerous or physically demanding tasks
- Application areas comprise almost all domains, for example:
 - **Logistics**: order picking, warehouse operations, last-mile delivery
 - **Construction**: material transport, positioning and fastening components
 - **Industry**: assembly, (un)loading machines, maintenance, inspection
 - **Service sector**: assistance in healthcare, retail or hospitality



Role of the Institute for Occupational Safety and Health

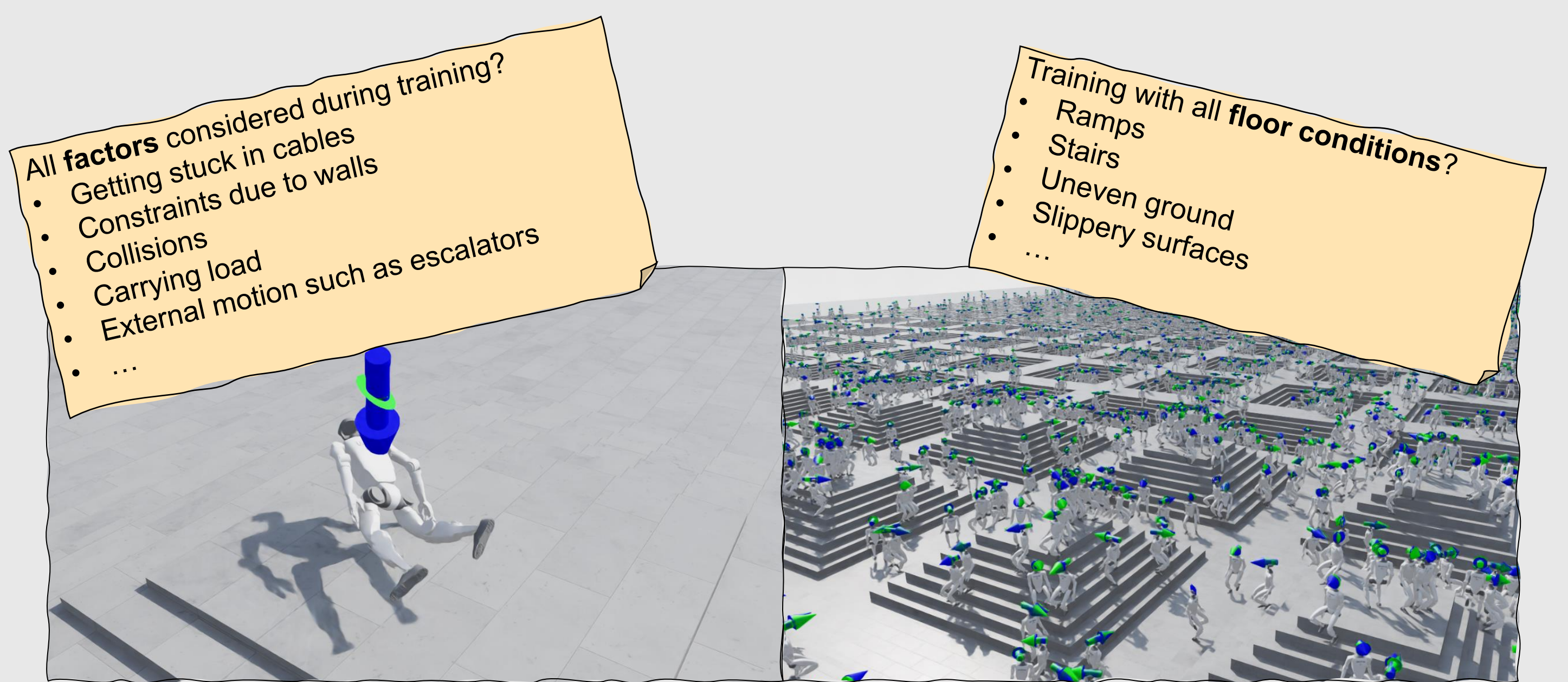
- Ensure **occupational safety** by participating in standardization
- Conduct **experiments** to assess risks
- Establish **test principles**
- **Consultation** of manufacturers and operators
- Carry out **examinations** (e.g., EC type-examinations)

Challenges in Safety

 Falling	 Noise	 Crushing
 Electricity and heat	 Knock over	 Collision with load
 Loss of energy	 AI for control	 Cybersecurity
 No functional safety	 Privacy	 Please dust your camera before approaching me. Ambiguity
 Expectations	 Lack of personalization	 Perceived safety

Application of Artificial Intelligence

- **Stabilization** of legged robots
 - Risk of unforeseeable behaviour and hazards during real applications
- **Perception** and interpretation of the robot's environment
 - Risk due to miss interpretation → wrong decisions taken by robot
- **Human-Robot-Communication** akin to ChatGPT
 - Risk of misunderstandings between person and robot



Digital twins of a humanoid robot during training runs.

All factors considered during training?
 • Getting stuck in cables
 • Constraints due to walls
 • Collisions
 • Carrying load
 • External motion such as escalators
 • ...

Training with all floor conditions?
 • Ramps
 • Stairs
 • Uneven ground
 • Slippery surfaces
 • ...

Standardization for legged robots

- Existing safety standards only partially applicable, e.g.:
 - ISO 10218-1 & -2 for industrial robots
 - ISO 13482 for service robots
 - ISO 3691-4 for mobile robots (AGVs)
 - ANSI RIA R15.08 for industrial mobile robots (US)
- Problem: insufficient consideration of **stability requirements**
- In development and planned for publication in 2028:
 ISO 25875-1: *Robotics — Part 1: Safety requirements for industrial mobile robots with actively controlled stability (legged, wheeled, or other forms of locomotion)*