

## Agile, lightweight, efficient, intelligent: Researchers are developing next-generation robots

**At the new Institute for Adaptive Mechanical Systems (IAMS) at the University of Stuttgart, the focus is on a new generation of walking robots and "soft robotics". The researchers are developing adaptable robots inspired by natural movement patterns and made from innovative soft materials. The applications range from healthcare and industrial production to energy supply. At IAMS, students find an exciting environment that combines basic research with practical development and emphasizes collaboration.**

"Our new Institute for Adaptive Mechanical Systems is another key component of interdisciplinary robotics research at the University of Stuttgart," explains Prof. Peter Middendorf, Rector of the University of Stuttgart. "As part of a globally recognized robotics ecosystem, IAMS helps develop solutions to major societal challenges. "The founding professors, David Remy and Philipp Rothmund, also exemplify a modern, internationally oriented approach to robotics education," says Middendorf.

### Harnessing physical intelligence

"We combine mechanics and robotics with physical intelligence," says Dr. David Remy, Chair of Legged Robotic Systems at the IAMS. Walking robots are now available commercially and perform tasks such as production maintenance and logistics transport. Remy aims to make them faster, more durable, and far more energy-efficient than they are today. "To achieve this, it is only natural to look to nature," says Remy.

### Next-generation robots

How can the passive mechanical movements that occur in humans and animals—which arise naturally from properties such as dynamics and elasticity—be transferred to robotics? How can this "physical intelligence" be harnessed? "We study biological processes and model them to understand their underlying mechanisms. "We always approach it from an engineer's perspective," explains Remy. For example, elasticity, as seen in muscles, tendons, and ligaments, could be replicated in robots through the use of springs. This could lead to walking robots that are more agile and efficient than today's systems as well as to exoskeletons and prostheses that are lighter and better adapted to the human body.

### New soft materials

Philipp Rothmund, Junior Professor of Functional Soft Robotic Matter at IAMS, works in an emerging area of research. He focuses on materials rather than structures and does not work with aluminum, steel, or carbon fibers as in conventional robots but rather with soft, often bio-inspired substances such as rubber. "This is fascinating not only from a mechanical standpoint," says Rothmund. "These materials can have inherent functionality." For example, the stiffness of a material changes by a factor of around 1000 when the temperature is raised or lowered. When a material is placed under tension, it can stretch to more than twice its original length. "This allows us to not only discover new material properties but also develop a wide range of functional capabilities."

Although the early-career researcher works primarily in basic research, he already has potential applications in mind. Artificial muscles integrated into active prostheses could, for instance, support patients during rehabilitation. And in the distant future, solar panels might orient themselves toward the sun through the inherent expansion and contraction of the material. "My focus is on embodied intelligence," says Rothmund.

### Well connected and innovative in teaching

Remy and Rothmund are well connected within the national robotics ecosystem. The IAMS collaborates with the research

center Bionic Intelligence Tuebingen Stuttgart (BITS) and the Max Planck Institute for Intelligent Systems (MPI-IS). It is also a partner of the Cyber Valley research consortium and Robotics Institute Germany (RIG). Both scientists bring extensive international experience that directly benefits their students. In their English-language lectures, both promote an interactive teaching style with practical components and innovative formats such as flipped classrooms. "Robotics is the perfect discipline for understanding concepts not only through formulas and equations but also intuitively, hands-on, and with an eye to real-world applications," says Remy. "Our students have the opportunity to help develop robots that won't be seen in action for another ten to fifteen years."

**About David Remy:**

David Remy has been a Professor at the University of Stuttgart since 2018 and now heads the Chair of Legged Robotic Systems at the Institute for Adaptive Mechanical Systems (IAMS). He researched and taught at the Department of Mechanical Engineering at the University of Michigan, Ann Arbor. His academic career took him to the University of Wisconsin–Madison and the Autonomous Systems Lab at ETH Zurich, where he earned his PhD in 2011.

**About Philipp Rothemund:**

Philipp Rothemund has been a Tenure Track Professor for Functional Soft Robotic Matter at the Institute for Adaptive Mechanical Systems (IAMS) at the University of Stuttgart and a visiting scientist at the Max Planck Institute for Intelligent Systems (MPI-IS) since 2023. He was elected spokesperson of the Junge Akademie (Young Academy) in 2025. His academic career has taken him to Harvard University in Cambridge, Massachusetts, and to the University of Colorado in Boulder. He earned his PhD in engineering in 2018.

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**Further information**

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