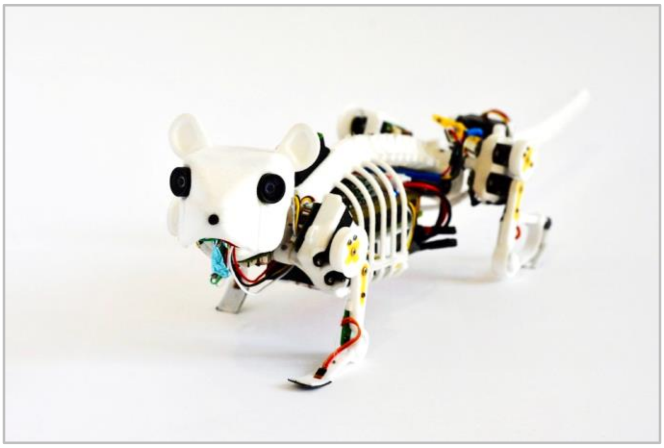
Compliant Neurorobotics

Neuroscience-based design for advanced control capabilities in robots



Nowadays, efficient and sustained manufacturing of robotic parts can be achieved at a reasonable cost and in relatively short time thanks to rapid prototyping technologies. However other challenges remain, such as the production of **lightweight robots** operating with **low power requirements**, equipped with a robust autonomous controller, and most of all, **safe for human-robot interactions**.

Safety is a main feature of **compliant robots**, but designing controllers that work well for them is still an open question. Leveraging advances in neuroscience, HBP researchers are employing **neural networks** to create biologically-inspired controllers that will allow compliant robots to achieve the **adaptivity** and **versatility** required for the next generation of robotic devices.

Following this approach, HBP developed a **mouse robot** that performs locomotor motions closely mimicking those of an actual rodent.

All actuators and robotic systems developed by HBP include elastic components that provide built-in mechanical compliance, thus achieving safety by design.

Built around the concept of **tendon-driven actuation** and embedding multiple sensors, this robot is a **universal research platform** for testing of new robotic features and functions inspired by neuroscience. With its virtual twin available in the HBP Neurorobotics Platform (the software toolset developed by HBP for embodied simulation) the robot mouse is ideal for studying how controllers developed in simulation perform in the real world.

The HBP robot mouse will also soon embed a **low-power neuromorphic hardware** to leverage the real-time computational power of spiking neural networks.

Human Brain Project

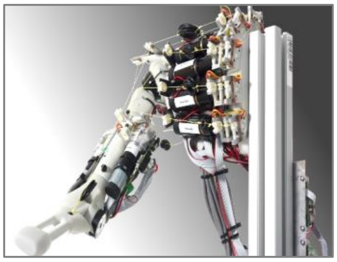
Co-funded by the European Union

TECHNOLOGY READINESS LEVEL

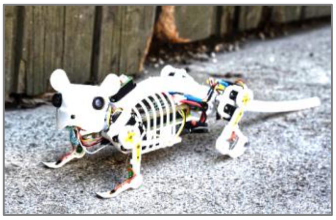
1 2 3 **4** 5 6 7 8 9

FEATURES

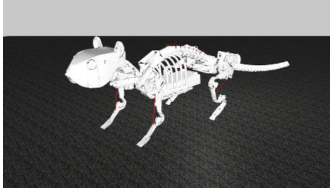
- ✓ Mechanically compliant, safe by design!
- ✓ Compatible with rapid prototyping technologies.
- ✓ Suitable for real-time controllers based on spiking neural networks: the right platforms to investigate adaptivity & continuous learning.
- ✓ Motor control through control theory, AI, neuroscience, or a combination thereof.
- ✓ Large repertoire of intrinsic dynamics, with attractor states coming about through interactions with the environment.
- ✓ Specific features of the mouse robot: flexible vertebra, tendon-driven actuations, foot pressure sensors, and a total of 13 DOF (including fully actuated head supporting stereo vision).



Anthrob arm



Mouse Robot V4.0…



… and its Digital Twin

APPLICATIONS

Low-cost research platforms for validation of scientific hypotheses, testing of novel applications, as well as evaluation of robotic model reliability.

Scalable, safe and robust design of compliant systems, ideal for projects that require robots to be in close proximity to humans (e.g. service robotics, cobots, etc.).

Experimental validation of *in silico* neuroscience by using actual compliant robots to reproduce simulations of musculoskeletal models on the HBP Neurorobotics Platform.

Virtual-to-real-world transfer learning of state-of-the-art approaches (e.g. Deep Learning, Reinforcement Learning) thanks to virtual twins on the HBP Neurorobotics Platform.

Fore more information, please visit:
https://myobrick.org/ http://www.neurorobotics.net/
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