BIO-INSPIRED ADAPTIVE MOTOR CONTROL AND AUTONOMOUS LEARNING FOR EMBODIED MULTI-SENSORIMOTOR ROBOTIC SYSTEMS

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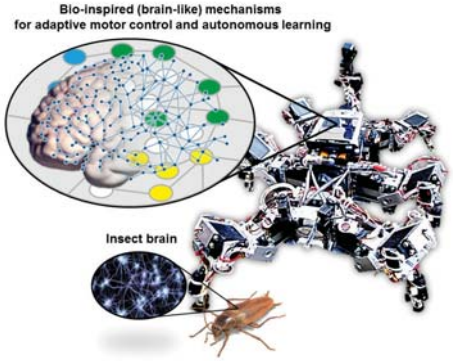
RESEARCH OVERVIEW

How can brain-like mechanisms be developed and realized on artificial systems so they can perform multiple complex functions as biological living systems? Addressing this fundamental question is one of the research goals of our Bio-inspired Robotics and neurAl engIneeriNg (BRAIN) laboratory. To achieve this, we employ a bio-inspired approach to develop brain-like mechanisms for adaptive motor control and autonomous learning of embodied multi-sensorimotor robotic systems (i.e., the robotic systems with many degrees of freedom that interact with the environment through their physical body). The developed mechanisms are adaptive and flexible, which can be transferred to application areas like human-machine interaction, brain-machine interface, and rehabilitation.

BIO-INSPIRED ADAPTIVE MOTOR CONTROL AND AUTONOMOUS LEARNING

The insect brain is a very efficient neural computing system. It can process high-dimensional sensory information and generate coordinated and adaptive motor commands in real time, resulting in various complex behaviors (including locomotion, object manipulation, navigation, and their combination). Simultaneously, it can also autonomously learn to solve complex tasks. This amazing control performance is achieved by using the full capacity of its neural dynamics, learning, memory, and plasticity as well as by interacting with the environment through its body (i.e., embodiment).



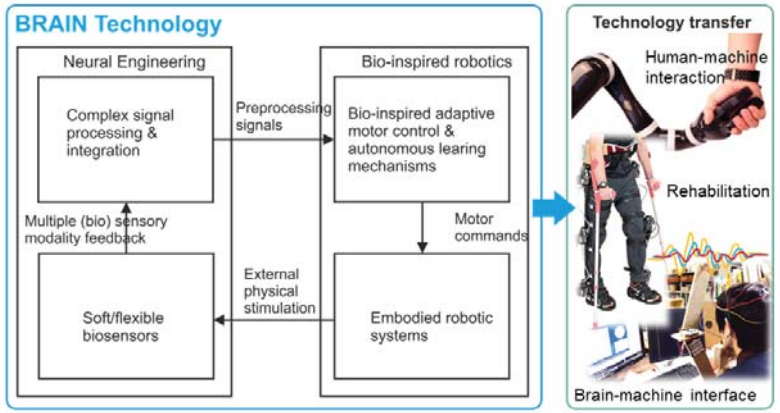
Inspired by this, we have developed brain-like mechanisms. The mechanisms are based on a modular concept and hierarchically organized. They exploit neural dynamics, learning, memory, and plasticity, as the biological brain does, to efficiently generate complex functions of embodied multi-sensorimotor robotic systems. Based on this development, we have addressed the way to achieve adaptive motor control and autonomous learning principles for complex locomotion, object manipulation, goal-directed navigation, and their combination in the embodied systems.

EMBODIED MULTI-SENSORIMOTOR ROBOTIC SYSTEMS

To validate the performance of the bio-inspired (brain-like) mechanisms, we employ different types of embodied multi-sensorimotor robotic systems (e.g., hexapod robot, humanoid robot, and robot arm) as our experimental platforms. They consist of different numbers of motors and different types of proprioceptive and exteroceptive sensors, allowing them to interact with complex environments and to perform various complex behaviors.

EMERGING TECHNOLOGY AND ITS TRANSFER

Due to adaptability, modularity, and flexibility of the bio-inspired mechanisms, they have been transferred to not only robotic but also medical domains, like orthosis control. Integrating the bio-inspired robotics research with neural engineering research leads to our emerging technology (called "BRAIN technology") which can be transferred to real world applications in the areas of human-machine interaction, brain-machine interface, and rehabilitation.



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