

## **Bidirectional Multiscale Neural Simulation**

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Mechatronics is an applied interdisciplinary science involving mechanical engineering, electronic engineering, and software engineering. There are two technical directions in biomechatronics. One is mechatronics which supports biological systems. Another is mechatronics which learns from biological systems. The former is realized by replacement of biological function such as artificial hearts and prosthetic hands, or by augmentation and rehabilitation of existing biological function such as brain-machine interface and deep brain stimulation. The latter is also called biomimetic or biologically-inspired robots such as humanoid and snake robots. Both biomechatronic systems are not necessary the same as the biological systems but their essences of biological functions are implemented by mechatronics.

Modeling and simulation based on mechanisms is important in order to design and control mechatronic systems. In particular, in-depth understanding and realistic modeling of biological systems is indispensable for biomechatronics. Biomechanical simulation is studied focusing on cardiovascular systems and musculoskeletal systems in the field of mechanical engineering and physiology, while neural network both artificial and biological ones are studied actively in the field of electrical and software engineering and of course in neuroscience.

The speaker has been developing bidirectional multiscale neural simulator, which estimates the neural and cognitive state of human through external measurement for the purpose of improving motor and social skills. Macroscopic anatomical nervous systems model was built which can be connected to the musculoskeletal model. Microscopic anatomical and physiological neural models were interfaced to the macroscopic model. Information flow between the nervous system and the musculoskeletal system is bidirectional, since the nervous system controls the musculoskeletal system and lengths and forces information is fed back to the nervous system. The research is promising for the novel diagnosis of neurological disorders and their treatments through medication and movement therapy, and for motor learning support system supporting acquisition of motor skill considering neural mechanism.