Multimodality Analysis for Modeling of Human Posture Control

Humans control their posture by controlling the muscular activity of the whole body with the cranial nervous system using multi-sensory inputs. The construction of sensory inputs and muscular activity model has a significant meaning medically and biologically because this model leads us to understand how the brain functions. For the modeling of the posture control, it is important that the brain controls the redundant muscles using multimodal sensory inputs. And it is also important that the muscular activity measurement can make it possible to consider not only torque activity to maintain their posture but also internal activity by antagonist muscles.

Therefore, the purpose of this study is obtaining changes in muscular activity by changing sensory inputs and finding the existence of the internal activity in human standing posture control.

One of the important things is how to change the sensory inputs. We propose a method for it by inhibiting or stimulating three senses which are related to the posture control as follows: A) visual sense is inhibited by closed eyes, B) vestibular sense is inhibited by a caloric test with pouring cold water into the ear cavity, and C) somatosensory sense is stimulated by touching a part of the body. And the existence of the internal elements is observed with muscular activity difference between the state in the inhibited or stimulated senses and the normal state.

Experiments were performed with the proposed method. When Subjects' senses were inhibited or stimulated, they tended to change their posture as follows: A) when only the vestibular sense was inhibited, subjects were able to maintain the standing posture (Fig.1A); B) when both visual and vestibular senses were inhibited simultaneously, subjects leaned (Fig.1B); and C) when both visual and vestibular senses were inhibited and somatosensory sense was stimulated, subjects recovered its standing posture (Fig.1C). From the results, the muscular activities can be observed more than the torque elements to maintain the posture when both visual and vestibular senses were inhibited. This finding indicates the possibility of new human posture control model in which torque elements are given with PID control from the sensory inputs, and also internal elements control make both antagonist muscles activate for the increase of stiffness from the sensory inputs (Fig.2).

Keywords: Mobiligence, standing posture control, sensory inhibition, multimodality analysis

Reference

[1] Hiroaki Ogawa, Ryusuke Chiba, Kaoru Takakusaki, Hajime Asama and Jun Ota, Method for obtaining quantitative change in muscle activities by difference in sensory inputs about human posture control, Proc. Int. Symp. on Adaptive Motion in Animals and Machines, 9/10 (2011)

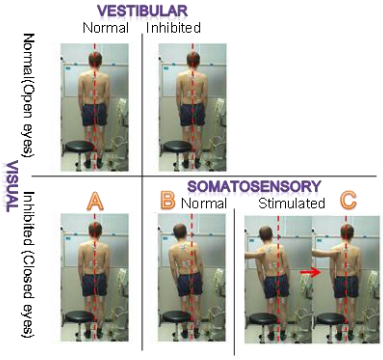

Fig.1 Postural changes

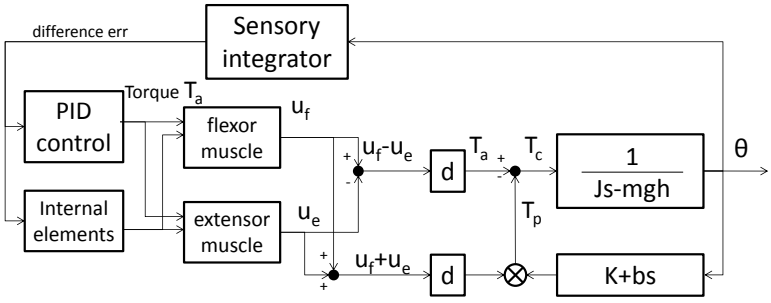

Fig.2 Posture control model with internal elements