Modeling Human Postural Control by Neural Controller Considering the Vestibulospinal Tract

Humans control their posture in their daily lives. When postural control is impaired by neurological diseases, their lives are restricted. It is essential to understand the postural control mechanism to reduce this restriction. The neural pathways play important roles in postural control. These neural pathways are the reticulospinal tract (RST) which controls stiffness (muscle tone) and the vestibulospinal tract (VST) which keeps their posture upright. However, the role of these neural pathways in human postural control has not been verified in detail. Therefore, we aim to verify the mechanism of human postural control by constructing a computational model focusing on these neural pathways.

We construct a computational model consisting of a musculoskeletal model with 17 degrees of freedom and 94 muscles and a neural controller model with controls based on the VST and RST. The validity of the computational model was verified by comparing simulation results to experimental results with human subjects. As a result, it was verified that control based on the VST enabled the musculoskeletal model to stand with lower muscle tone. In the absence of vestibulospinal tract-mimicking control, the postural sway was larger (Fig. 2). These results were similar to those obtained in actual human experiments. This confirms the validity of the constructed computational model [1]. By using this computational model, we aim to elucidate the mechanism of human postural control.

Keywords: Posture control, Vestibulospinal tract, Muscle tone

References

[1] Y. Omura, K. Kaminishi, R. Chiba, K. Takakusaki, and J. Ota, "A Neural Controller Model Considering the Vestibulospinal Tract in Human Postural Control," Front. Comput. Neurosci., vol. 16, 2022, doi: 10.3389/fncom.2022.785099.

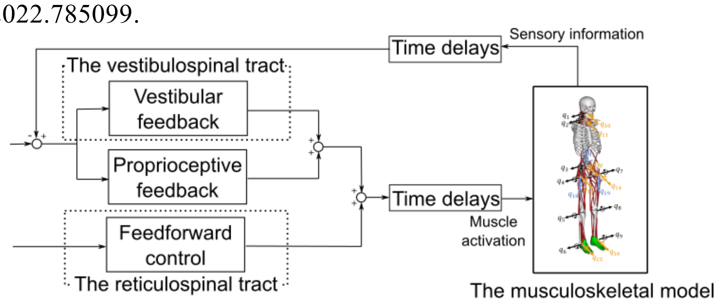

Figure 1. Computational model. The model consists of feedforward control based on the reticulospinal tract and feedback control based on the vestibulospinal tract. In addition, time delays due to information transmission and muscle activity are considered.

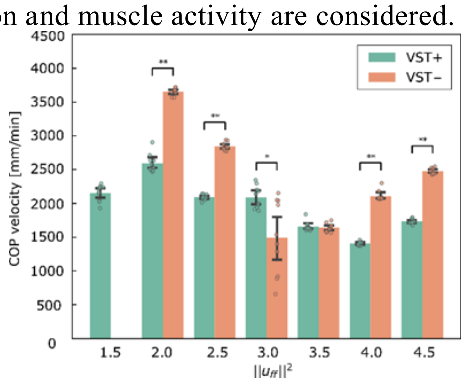

Figure 2. Center of pressure (COP) velocity. The green bar denotes COP velocity without VST. The orange bar denotes COP velocity with VST.