Modeling of human gait and gait initiation

Gait and gait initiation are daily tasks for us. Therefore, when these are disturbed due to aging or disease, they can greatly impair our daily lives. In order to prevent the occurrence of such disorders and to perform rehabilitation effectively, it is important to understand the mechanism of human gait. Our approach is to create a controller model and control the musculoskeletal model on a computer.

Although various modeling studies have been conducted on gait control, no gait simulation that controls a body model capable of three-dimensional motion has been realized. One of the challenges is the difficulty in adjusting control parameters because the body model needs many joint degrees of freedom. We propose an approach in which the control parameters are adjusted by adding joint degrees of freedom step by step, starting from a condition with a small number of joint degrees of freedom. This approach has enabled a musculoskeletal model with 70 muscles and 15 joint degrees of freedom to walk.

The gait initiation, which is the transition from stance to gait, is an important movement that is often impaired and may lead to falls. During gait initiation, it is known that a characteristic phenomenon (anticipatory postural adjustment, APA) is observed, in which the center of pressure of the foot shifts backward once, but the necessity of this phenomenon has not been fully elucidated. We have developed and investigated a neural controller model for stance, gait, and gait initiation. We found that simply switching between stance and gait control is not sufficient to make the transition from stance to gait. In addition, APA was observed even though the control parameters were adjusted to achieve the transition to gait, suggesting the usefulness of APA in the gait initiation.

At present, some of the features of the model motion are different from those of actual human motion. In the future, we will investigate the causes of this difference, examine the limitations of the model, and analyze the effects of aging and disease on the model.

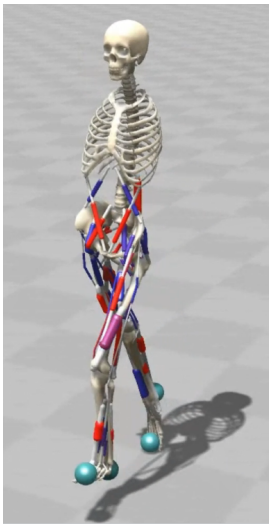

Figure 1. The musculoskeletal model used in gait simulation (70 muscles and 15 joint degrees of freedom).

Keywords: Gait, Gait initiation, Musculoskeletal model, Forward dynamics simulation

References

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