

Representation of Postural Abnormalities in Parkinson's Disease Patients Using a Computational Model

Parkinson's disease (PD) is a neurodegenerative disease with postural abnormalities and motor dysfunction. Although there is a concern that the number of patients will increase as the number of elderly increases, the pathological mechanisms have not been fully elucidated. Therefore, as a methodology for understanding the mechanism, we focus on postural abnormalities, which are characteristic of PD, and aim to construct a computer model of postural control in PD. This study aims to represent postural abnormalities on a computer model as an initial step [1].

Our research group proposes a neural system controller model (Fig. 1) that can maintain the musculoskeletal model (Fig. 2) in the upright standing posture (Fig. 3(A)) [2]. The musculoskeletal model is composed of 94 muscles with 17 degrees of freedom, including the neck, which is sufficient for postural abnormalities. The nervous system controller model consists of feedforward control, which outputs the steady muscle activity (muscle tone) required to maintain a standing posture, and feedback control based on sensory input. Using these models, the parameters of a neural postural control model that can maintain standing with an abnormal posture of PD (Fig. 3(B)) as the target posture are calculated by optimization. As a result, the maintenance of a standing position was succeeded even with abnormal posture, and it was confirmed that the posture abnormality could be represented on the computer model. When the abnormal posture was used as the target posture, there was an increase in the value of muscle tone that could be maintained in standing, suggesting that the abnormal posture increased the muscle tone needed to maintain standing.

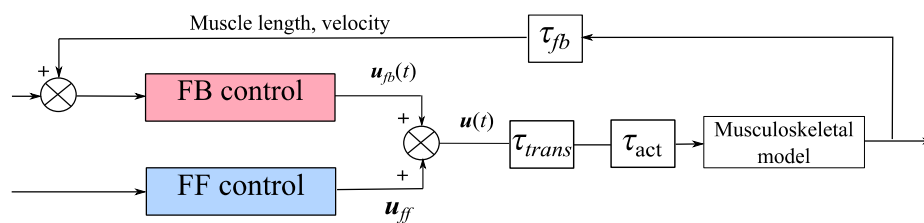


Figure 1. Neural controller model. $u_{fb}(t)$, u_{ff} , $u(t)$: feedback, feedforward, and integrated output. τ_{fb} , τ_{trans} , τ_{act} : transmission, feedback, and activation time delay.

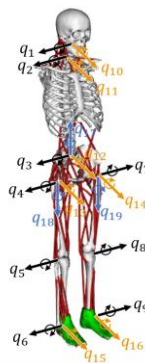


Figure 2. Musculoskeletal mode



(A) Upright posture



(B) Abnormal posture

Figure 2. Musculoskeletal mode

Keywords: Parkinson's disease, Posture control model, Abnormal posture

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