Dynamic Computer Optimization for Standing Balance and Control of Postural Sway after Spinal Cord Injury

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Abstract

This study explores the use of dynamic optimization to determine muscle excitations needed to restore balance in human bipedal standing. The human musculoskeletal system is modeled as a system of 11 connected rigid segments actuated by 52 lower extremity muscles modified to mimic muscles of individuals with spinal cord injury (SCI). Passive properties modelling the effects of ligaments and other joint structures for SCI individuals \cite{2} were incorporated. Not all 52 muscles can be stimulated using current FES implant technologies. Earlier studies using static optimization \cite{1} have identified a subset of muscles for a 16-channel stimulator to keep the body in equilibrium at different non-erect postures. The current study assesses the performance of this muscle set for its ability to restore posture in a dynamic setting. The results show that the maximum area of the base of support (BOS) within which the postures can be restored to the erect one is 7\% of the total attainable. This adequately covers the path which will be traversed by the path of the center of pressure in steady standing and under small disturbances to the standing balance. These preliminary results are an encouraging indication that standing balance control is realizable with suitable choice of muscles to stimulate with FES.

References


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