Modeling and Simulation of Foot Drop Correction Using Biomechanical Legs

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Abstract

This PhD thesis explores an alternative approach to the study and investigation of foot drop (weakness of the dorsiflexion muscles of the foot) problem which is currently being treated by ankle foot orthosis, functional electrical stimulations, and rehabilitation exercises. This problem occurs due to various reasons, such as a nerve injury. The foot drop issue leads to the inability to lift the front part of the foot and hence it causes the toes to be dragged while walking. This PhD thesis provides a model of a biped robot which can simulate human cases of foot drop geared towards improving its treatment. The overarching goal of this study is to produce the required torque data that will be converted into muscle signals to treat real foot drop cases. The model of the biped robot is described along with tools necessary for simulating contact with the ground and generating gait data using a simulated robot. Specifically and as a contribution of this study, a unique representation of the foot segment (ankle and toe joints) with a foot drop has been simulated. A conventional feedback controller is used to correct the simulated case of foot drop. The process of setting up the controller parameters, depending on the type of foot drop, is documented, and the broad strategy for solving various foot drop cases is illustrated. The results from considering a study case of a foot drop problem is represented and discussed. The results show the capability of this proposed model to simulate and correct the assigned foot drop issue into the ankle joint.

were performed using the real-time values of water surface elevation and current. The vertical turbulent eddy viscosity and diffusivity in the 3D model were computed using the turbulence closure model. The sensitivity of the three turbulence closure models (namely k-Ɛ, k-L, and algebraic model) was compared with the field data extracted by ADCP deployed at three coastal locations near Muscat city. The vertical profile analysis using the curve fitting demonstrated that the 1/5th power law best outlines the shape of ADCP and the 1/6th power law for the turbulent model, compared to the typical 1/7th power law.