Developing an Intelligent Controller for lower limb Neuroprosthesis Part I:Designing of The Training Data*

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Abstract

Neuroprosthesis can be used to restore lost motor functions for paraplegicsby using functional electrical stimulation (FES). Neuroprosthesis controllers determine the relationship between the stimulation pulses and joint angles to generate electrical stimulation patterns for the desired movement.To develop intelligent controllers, an inverse model which is the basic component of the intelligent controller is built by using empirical approaches to get a data set that consists of input (stimulation pulses) and output (joint angles). Because of the numerous exhausting experiments on patients and the need for repetition during Controller design, this study uses modeling and simulation to generate the data setthrough developing humanoid model, and simulating practical trials of quadriceps stimulation during swing leg movement.

We connected three programs to develop a humanoid model by building: body segments in Visual Nastran 4D, muscles in Virtual Muscle 4.0.1, and passive joint properties in Matlab/ Simulink. Then the humanoid model was used to producethe identification data sets, through applying sinusoidal and random signals to simulate the stimulation of the knee extensors.

The humanoid model can fit different users by using a number of graphical user interface screens to change the human and muscles parameters, so it is a generic model. It can be used in developing controllers to restore lost movement such as standing up, walking, jumping, etc.

The simulation results is similar to practical trials, so using the developed model can reduce the number of experimental tests to be performed with patients during Neuroprosthesis controllers design.

Keywords: Functional Electrical Stimulation, Neuroprosthesis, Inverse Model, Humanoid Modelling, Simulation.

- For The paper in Arabic see pages (325-345)

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