NEUROSCIENCE 2012

Presentation Abstract

Program#/Poster#:	274.10/JJ8
Presentation Title:	Less is more: Efficient identification of human stance control with parametric subspace identification
Location:	Hall F-J
Presentation time:	Sunday, Oct 14, 2012, 2:00 PM - 3:00 PM

Authors: ***D. ENGELHART**[1], A. C. SCHOUTEN[1,3], R. G. K. M. AARTS[2], H. VAN DER KOOIJ[1,3];
[1]Lab. for Biomechanical Engin., [2]Dept. of Mechanical Automation, Univ. of Twente, Enschede, Netherlands; [3]Dept. of Biomechanical Engin., Delft Univ. of Technol., Delft, Netherlands

Abstract: The human balance control system is a complex mechanism with many underlying neural feedback loops. In order to identify the stabilizing mechanisms generated by the central nervous system during upright stance, perturbations and closed-loop system identification techniques (CLSIT) are required [v.d. Kooij, 2005]. Many CLSIT used to investigate human balance control are based on non-parametric methods in the frequency domain, relating the signals with the external perturbations. Although, these non-parametric CLSIT give insight about specific dynamic behavior of a human, they do not directly quantify the underlying physiological parameters of the feedback loops and do not take advantage of the common structure between the signals and the perturbations.
As an alternative identification technique, we have adopted the Prediction Based Subspace Identification (PBSID) method [v. Wingerden, 2008]. This method has several theoretical advantages for use in closed loop data, as with the central nervous system controlling the human body. With subspace techniques a parametric model structure is obtained, relating to physiological parameters, without a priori assumptions about the underlying model structure. In addition subspace identification is well suited for Multiple-Input-Multiple-Output (MIMO) systems; in case of the human stance model the contribution of both ankle and hip joints can easily be incorporated for a more realistic representation of the human body.
To test the PBSID subspace identification method for balance control, simulations were performed in Matlab. The human body is modeled as a double inverted pendulum, incorporating an ankle and hip joint, with a stabilizing mechanism (controller), activating dynamics and neural time delays. In the simulations two independent continuous perturbations are applied at hip and shoulder level and multiple realistic levels of measurement noise were simulated.

The simulations demonstrate that subspace identification estimates the stabilizing mechanism at least as good as a non-parametric CLSIT. The PBSID algorithm provides consistent estimates, also in case of short sample lengths. Furthermore, the method is robust against measurement noise, which can reduce experimental measurement time in humans. Reduction of experimental time is an advantage especially in pathological stance. A drawback of the method is that consistency depends on proper model order selection, which can be difficult in case of high noise. In short, subspace is a good alternative over nonparametric methods, implicitly handles MIMO systems, and can deal with short measurement time.

Disclosures: **D. Engelhart:** None. **A.C. Schouten:** None. **R.G.K.M. Aarts:** None. **H. van der Kooij:** None.

Keyword(s): BALANCE CONTROL

MODELING

SYSTEM IDENTIFICATION

Support: STW NeuroSIPE

[Authors]. [Abstract Title]. Program No. XXX.XX. 2012 Neuroscience Meeting Planner. New Orleans, LA: Society for Neuroscience, 2012. Online.