

Stratification of the phase clouds and statistical effects of the non-Markovity in chaotic time series of human gait for healthy people and Parkinson patients

Renat Yulmetyev^{a,*}, Sergey Demin^a, Natalya Emelyanova^a,
Fail Gafarov^a, Peter Hänggi^b

^a*Department of Physics, Kazan State Pedagogical University, Mezhlauk Street 1, 420021 Kazan, Russia*

^b*Department of Physics, University of Augsburg, Universitätsstrasse 1, D-86135 Augsburg, Germany*

Received 24 June 2002

Abstract

In this work we develop a new method of diagnosing the nervous system diseases and a new approach in studying human gait dynamics with the help of the theory of discrete non-Markov random processes (Phys. Rev. E 62 (5) (2000) 6178, Phys. Rev. E 64 (2001) 066132, Phys. Rev. E 65 (2002) 046107, Physica A 303 (2002) 427). The stratification of the phase clouds and the statistical non-Markov effects in the time series of the dynamics of human gait are considered. We carried out the comparative analysis of the data of four age groups of healthy people: children (from 3 to 10 year olds), teenagers (from 11 to 14 year olds), young people (from 21 up to 29 year olds), elderly persons (from 71 to 77 year olds) and Parkinson patients. The full data set are analyzed with the help of the phase portraits of the four dynamic variables, the power spectra of the initial time correlation function and the memory functions of junior orders, the three first points in the spectra of the statistical non-Markov parameter. The received results allow to define the predisposition of the probationers to deflections in the central nervous system caused by Parkinson's disease. We have found out distinct differences between the five submitted groups. On this basis we offer a new method of diagnostics and forecasting Parkinson's disease. © 2002 Elsevier Science B.V. All rights reserved.

PACS: 02.50.Ey; 05.45.Tp; 87.19.Tt; 89.75.–k

Keywords: Stochastic processes; Time-series analysis; Movement and locomotion; Discrete non-Markov processes; Complex systems

* Tel.: +7-8432-32-07-79; fax: +7-8432-32-42-69.

E-mail address: rmy@ntp.ksu.ras.ru (R. Yulmetyev).