

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/226082972>

Automatic Step Detection in the Accelerometer Signal

Chapter in IFMBE proceedings · January 2007

DOI: 10.1007/978-3-540-70994-7_14 · Source: dx.doi.org

CITATIONS

68

READS

1,167

5 authors, including:



Hong Ying

Northeast Normal University

10 PUBLICATIONS 122 CITATIONS

[SEE PROFILE](#)



Andreas Schnitzer

10 PUBLICATIONS 126 CITATIONS

[SEE PROFILE](#)



Steffen Leonhardt

RWTH Aachen University

558 PUBLICATIONS 3,222 CITATIONS

[SEE PROFILE](#)



Michael Schiek

Forschungszentrum Jülich

51 PUBLICATIONS 357 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



Development of a robust Wireless Underground Sensor Network (WUSN) supporting early warning of slope instability in hillslopes [View project](#)



Biomon-HF [View project](#)

All content following this page was uploaded by [Michael Schiek](#) on 02 July 2014.

The user has requested enhancement of the downloaded file.

Automatic Step Detection in the Accelerometer Signal

H. Ying¹, C. Silex¹, A. Schnitzer¹, S. Leonhardt², and M. Schiek¹

¹ Central Institute for Electronics, Research Centre Jülich, Germany

² Philips Chair for Medical Information Technology, RWTH Aachen University, Germany

Abstract— The automatic step detection is a crucial component for the analysis of vegetative locomotor coordination during monitoring the patients with Parkinson's disease. It is aimed to develop the algorithms for automatic step detection in the accelerometer signal, which will be integrated in sensor networks for neurological rehabilitation research. In this paper, three algorithms (Pan-Tompkins method, template matching method and peak detection based on combined dual-axial signals) are detailed described. Finally, these methods will be discussed by means of dis- and advantages.

Keywords— Step detection, accelerometer, Pan-Tompkins method, template-matching method, neurological rehabilitation research

I. INTRODUCTION

Parkinson's disease (PD) is associated with reduced coordination between respiration and locomotion [1]. For the neurological rehabilitation research, it requires a long-time monitoring system, which enables the online analysis of the patients' vegetative locomotor coordination. The online analysis allows the later integration of bio-feedback protocol for the rehabilitation purpose. This system will facilitate the identification of the therapeutic effect and measuring the patients' health status. To monitor the phase synchronization between respiration and locomotion, the accurate time of step event has to be determined. The commercial pedometers, which count each step a person makes, can not fulfill this requirement. For this purpose, the online algorithm is developed for the automatic step detection. Since the characteristics of the PD patients' gait are pronounced different from the normal gait [2], the database for algorithm development in our work is acquired only from the PD patients.

The first experiment on the locomotion measuring is carried out using accelerometer. The accelerometer signals show considerable difference in morphology and amplitude among the individuals. We attempt to design a fast and robust algorithm, which should be suitable for individual patients, without any user-specified parameters. So far, three methods have been investigated for this project:

- Pan-Tompkins Method
- Template-Matching Method

- Peak-detection method based on combined dual-axial signals.

These three algorithms will be described in detail below, as well as their preliminary results on the patients' data. Finally, the dis- and advantages of these methods will be discussed.

II. METHODOLOGY

A. Subjects and Equipment

Subjects: In total, eight patients suffering from PD were measured in the Clinic Ambrock for Neurology, Centre for Sleep- and Rehabilitation Research, Germany. The patients are at different stage from 1 through 4 according to unified rating scale (UPDRS). To evaluate the algorithms, data in total duration of 115 minutes were collected from eight recordings. They are acquired at a sample rate of 200 Hz. The patients were walking on a treadmill with accelerometers attaching on the lateral side of the left and right feet during the measurement. Meanwhile, the abdominal and thoracic respiration signals were measured and acquired with a sample rate of 20 Hz.

Equipment: The horizontal and vertical acceleration in x- and z-axis generated from the locomotion during steps is measured by ADXL322, a low power dual-axis accelerometer, produced by Analog Devices, Inc. The schematic circuit diagram of the accelerometer for activity measuring is provided in Fig.1 below. The accelerometer is supplied by battery voltage through a low-dropout voltage regulator (TPS77027) to maintain constant 2.7 V level. To improve transient response and noise rejection, a 1 μF ceramic capacitor (C_{DC}) is connected between V_{RIN} and GND. The voltage regulator requires a 4.7 μF capacitor (C_{ROUT}) connected between V_{ROUT} and GND. The output of regulator is brought into ADXL 322 through pin Vs. The ADXL322 contains two 32 $k\Omega$ resistors (R_X and R_Y) in each output inside IC, respectively. The 0.1 μF capacitors (C_X and C_Y) are added at the pins X_{OUT} and Y_{OUT} to implement passive low-pass filtering of 50Hz, first order, to eliminate high frequent noise. The output signals: V_{AOUTX} and V_{AOUTY} are analog voltages that are proportional to acceleration.