Acquiring and analyzing epileptic seizure motion data – technical considerations

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Abstract and Objective

Introduction: Epilepsy is one of the most chronic diseases. Sudden seizures cause the total loss of body control and result in a decreased quality of life. These seizures also impose a high risk of partly severe injuries. In order to detect any epileptic seizures, it is imperative to continuously monitor the patients. Current possibilities (e.g. combined video and electroencephalogram monitoring) are reliable but limited to stationary, short term observation. Thus, wearable systems with automated seizure-detection are needed. Here, accelerometer-based motion sensors seem promising. For the development of the required detection-algorithm, motion data of real epileptic seizures must be acquired and analyzed. Aim: This contribution describes the development of a comprehensive system for the acquisition and analysis of epileptic seizure motion data. Method: Requirements for system development were collected by combining literature review and qualitative expert interviews. The system development mainly applies open-source solutions. Results: A concise list of requirements for the acquisition of motion data. An easily usable data acquisition interface. A graphical analysis system that comprises mathematical processing functions. Conclusion: The developed systems help acquiring characteristic motion features of epileptic seizures that are essential for detection algorithms.

Keywords:

Patient monitoring, Epilepsy, Acceleration

Methods

Necessary requirements of a mobile epilepsy-seizure detection system were collected by combining a qualitative literature review and expert interviews. This resulted in an overview over existing wearable motion sensors, their strengths and weaknesses. Based on this, the ADXL 330 motion sensor from Analog Devices was selected. It is used in the controller (i.e., WiiRemote®) of the gaming console Nintendo Wii®. An own data interface was developed based on the WiiUse-API. It is implemented in ANSI C and easily portable on different platforms. A Debian-Linux operating system served as a basic platform for the interface. The BlueZ Bluetooth-stack was used for connecting up to four WiiRemotes. Further, an own application for visualizing and analyzing the acquired motion data was implemented on basis of MatLab.

Results

Crucial requirements for this task were collected (e.g., data ratio, measurement accuracy, battery life, degrees of freedom, connectivity). The implemented data interface allows the simultaneous connection and recording of several WiiRemotes®. All recordings are labeled uniquely, separated into packages and stored persistently on the hard drive. A Live-CD comprises an operational Linux system with the interface software. The analysis system provides the user with an adequate visual representation of the motion data and possibilities to manipulate this data with basic mathematical functions. New processing functions can be added easily. It is also possible to export either the processed or the raw motion data into common data formats (e.g., comma separated values, CSV).

Conclusion

To the current knowledge no mobile epileptic seizure detection system exists. However, accelerometer-based motion sensors seem adequate as a basis for a mobile seizure detection system. In order to develop the algorithm that is required for the automated seizure detection, the characteristics of real epileptic seizures must be determined first. The systems introduced in this contribution were especially developed to provide possibilities for acquiring the relevant motion data and for analyzing that data regarding characteristic features. The systems have already been used to acquire and analyze motion data of real epileptic seizures in a specialized epilepsy department.