ROTATION-INVARIANT DETECTION OF 2D-GESTURES USING 3D-ACCELEROMETERS

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Abstract

3D-Accelerometers are often used as sensors to automatically detect gestures and activities in different settings. A lot of relevant gestures should be executed in some two-dimensional plane; the orientation of this plane can however change from measurement to measurement. In this work we show that projecting the raw sensor data to two dimensions can have a positive effect on the accuracy of correctly classified gestures.

Keyword(s): biosignals

1 Introduction

Recently, there is a growing interest in systems that can automatically monitor the behavior of people. Such systems are interesting for different applications ranging from e.g. the monitoring of elderly people with dementia to the follow-up monitoring of people in revalidation, using different kinds of sensor information.

In this work, we focus on the automatic detection of gestures using accelerometers. More specifically, we want to investigate if more accurate methods can be developed when using the information that a lot of activities and gestures are executed in some two-dimensional plane. Although we are interested in two-dimensional gestures, the execution of these gestures is never completely in a two-dimensional plane due to user variance and sensor noise. The orientation of the plane will moreover change due to the user and the placement of the accelerometer.

2 Two-Dimensional Projection and Rotation

We consider two transformations that can potentially increase the performance of standard algorithms: 1) 2d-projection to reduce user variance and sensor noise and 2) rotation to reduce dependence on the specific placement of the accelerometer. The projection operation applies Principal Component Analysis (PCA) and then uses the first two principal components to form the plane in which the gesture was executed. This projection allows for a unique rotation operation that aligns the measured G-force with some reference direction. Note that this rotation in 3D is not unique.

3 Preliminary Experiments

The data used in these experiments was acquired using a standard Wiimote. We asked a user to perform three different gestures (writing the number '0', '1' and '2') while holding the Wiimote in six different orientations (normal writing on a table, writing while holding the Wiimote orthogonal to the table, writing against a vertical wall, 'writing in the air', normal writing on an inclined table, orthogonal writing on an inclined table). We measured every gesture four times and recorded the accelerations given by the Wiimote in three orthogonal directions.

In the following experiments, we converted the different channels from the accelerometer to the frequency domain using a 512-point FFT and used these as features. We applied the LS-SVM method using a standard RBF kernel.

To evaluate our approach, we build a model using the measurements from 1, 2 or 3 different orientations and test the accuracy on the examples in the remaining orientations. The following table shows the results averaged over 50 runs (using different orientations to build the model) for experiments where projection (P), rotation (R), the combination of both or no preprocessing (No) is used.

	1	2	3
P+R	59.6±12.7	76.2±8.7	81.2±6.9
P	53.9±8.9	66.1±13.4	66.9±9.6
R	38.6±5.8	58.8±13.6	67.4±14.6
No	42.9±8.1	54.7±8.1	66.9±9.6

4 Conclusions and Future Work

Preliminary experiments indicate that the combination of projection onto a 2-dimensional plane and rotating to a reference direction during the preprocessing phase can increase the accuracy of the resulting system when classifying gestures that are executed in a two-dimensional plane.

There are several directions for future work; the most important is to test this method on a bigger dataset. We furthermore plan to test if this approach can also be beneficial for standard activities such as e.g. walking, running and taking the stairs.