Performance Comparison of Two Step Segmentation Algorithms using Different Step Activities

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Introduction

Motivation
Insufficient physical activity = 4th leading risk factor for mortality

Field of Application
Activity recognition in the field
Classification of movement disorders (e.g. Parkinson’s disease)
Robust step segmentation in daily life

Hardware & Preprocessing
2 SHIMMER sensor nodes (204.8 Hz)
- 3-D accelerometer
- 3-D gyroscope
Butterworth filter
- Order: 2
- Type: low-pass
- Cutoff frequency: 17 Hz

Methods

Study Design
15 healthy subjects (8 female, 7 male):
Exercises:
- Walking (twice)
- Jogging (twice)
- Ascending stairs
- Descending stairs
Basic Step Activity (BaSA) dataset
BaSA dataset download: http://www.activitynet.org

Evaluation
Leave-one-subject-out cross-validation
Performance measure:
Error rate = \(|\text{# reference steps} - \text{# calculated steps}| / \text{# reference steps} \times 100\%

Statistics:
- Multivariate Analysis of Variance (ANOVA)
- ANOVA with repeated measures
- Post-hoc t-tests with Bonferroni correction

Peak Detection Algorithm
Detection of steps:
- Threshold-based maxima determination
- Minimum time (iteratively adapted)
- \( v_i(t) > 100°/s \) & \( v_{i+1}(t) < 0°/s \)
- \( v_i(t) < 0°/s \)

Subseq. Dynamic Time Warping

One Step
Several steps

Results

Error Rates

Lowest error rates for walking: peak detection algorithm and sDTW (Template Walking)
- Most steps in walking activities
- Template Walking has lowest SD around mean performed similarly

Discussion

Highest error rates with Mixed Template:
- Jogging and walking temporal phases differ considerably
- No representation of normal step or a jogging step

Comparison of calculated steps with total number of steps

Summary & Outlook

BaSA dataset with realistic and natural movements
Peak detection and sDTW algorithm with equal performance
- Comparison of calculated steps with identical steps
- Investigate performance in transitions (e.g. walking \( \rightarrow \) jogging)
- Adaptive approach according to activity

References

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