

Improved estimation of starting times of human activities using Hidden Markov modeling based activity classification?

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INTRODUCTION

Automated classification of human activities should help the researcher, or the physician, with the interpretation of data, as it will automatically label, or subdivide, large quantities of data. In a previous study, a novel activity classifier based on Hidden Markov Models (HMMs) was successfully implemented and tested on ambulatory obtained of human activities [1]. However, the estimated starting times of the activities were not accurate. Here, the addition of timing information to perform isolated activity training as initialization of the HMMs is proposed to more accurately estimate the starting times of activities.

METHODS

Acceleration and angular velocity data was collected at 25 Hz with sensors attached to the subjects back at the level of the S4 and the C7 vertebrae. The subject was directed through an alternating series of activities, consisting of four different ways of lifting a crate (from left, from right, stooping and squatting), putting the load down, walking, standing and sitting. Five measurements of ~10 minutes containing ~120 activities were registered. In a time consuming process a description file, containing the activities and the accompanying starting times, was created by hand. 30 minutes of data and the description file were used to train 5-state forward connected HMMs over 15 training iterations. The HMMs were initialized using isolated activity training. Training and testing set were chosen five times from the 5 measurements. Classification accuracy and estimated starting times of the resulting activity classifier were compared with the classification accuracy and estimated starting times of the original activity classifier.

RESULTS

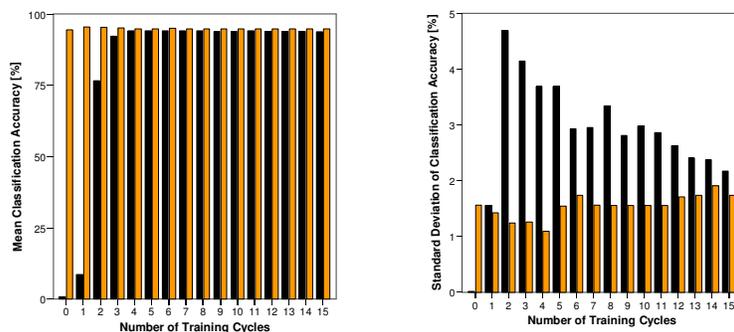
Initialization with isolated activity training did not significantly influence classification accuracy. However, good classification performance was already achieved with no additional training (Fig 1). Furthermore, the standard deviation of the resulting classification accuracy was almost twice as small after 5 training cycles. Decrease in error of the estimated starting time of activities was achieved. Without initialization the absolute estimation error was 619 ± 1041 msec. Initializing the HMMs resulted in an absolute estimation error of 212 ± 206 msec.

DISCUSSION & CONCLUSIONS

Increased preparation time before the activity monitor can actually be trained is a drawback of the proposed method. All starting times have to be manually labeled. On datasets of 30 minutes this involves 360 activities. Major advantage is gained regarding the estimated starting times of activities. Classification accuracy does not increase. Therefore, isolated activity training is only advised if an estimation of the starting times of activities are required as an output of the activity classifier.

REFERENCES

[1] Wassink R, Baten C, Veltink P. Classifying Human Lifting Activities Automatically by Applying Hidden Markov Modeling Technology. *Journal of Biomechanics*, 2007; 40: s428.



Figuur 1: Mean classification accuracy (left) and standard deviation of the classification accuracy (right) of the activity monitor per training cycle. Light bars are the results of the initialized activity monitor, dark bars of the plain activity monitor.