Automatic recognition of health problems through the movement analysis

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Abstract and Objective

Due to aging of population, less people are capable of taking care for elderly. We propose an intelligent and ubiquitous care system for monitoring elderly in order to recognize a few of the most common and important health problems, observable through the movement. Movement is captured with wearable infra-red motion capture system, whose outputs are positions of tags at each moment. According to our approach positions of tags are transformed into specific features, relevant to the observed health problems, making the modeling of the health problems patterns more accurate. For the modeling, Support Vector Machines (SVM) machine learning algorithm is used, which classifies walking of user into walking with hemiplegia, Parkinson's disease, pain in the back, pain in the leg or nothing of those. The obtained classification accuracy is 85-95%. Also, the study of the impact of tag placement and noise level on the accuracy of detection of health problems is presented, as a guidance for future research.

Keywords:

Health problems recognition, Machine learning, Motion capture

Methods

In related work, recognition of health problems is usually done in the way that motion capture systems are used for capturing of movement which is later examined by the medical experts by hand [Ribarič et al., Informacije MIDEM 37(2007)2; Moore et al., Gait Posture (2006)].

Our goal was to make the detection automatic. For this purpose, user wears 12 tags attached to shoulders, elbows, wrists, hips, knees and ankles. His/her movement is captured with wearable infra-red motion capture system, whose outputs are positions of tags at each moment. The movement is modeled with SVM. Because with time-series of positions of tags for feature vectors performance of model was not sufficiently good, we constructed specific features, according to the features observed by the physicians. Examples of the constructed features are average frequencies of joints moving, which are crucial for detecting Parkinson's disease. After evaluation of features we kept 13 features, used for feature vectors for the SVM. Also other machine learning algorithms were used but SVM outperformed them. To test the robustness of the approach, we added varying degree of Gaussian noise to the raw coordinates. To make the variation of noise more genuine, the Ubisense Real-Time Locating System noise was added to the tag coordinates, with its standard deviation 4.36 cm horizontally and 5.44 vertically. We hereafter refer to the levels of noise in multiples of the Ubisense noise.

Since wearing the full complement of 12 tags may be annoying to the user, we investigated ways to reduce the number of tags. We started with all 12 tags and then removed them in the order that achieved the best performance. In addition, the interplay between tag placement and noise level was studied. The experimental results were obtained by leave-one-person-out method, which means that the recordings of all the persons but one were used for training and the recordings of the remaining person for testing.

Results

According to Figure 1 below, the classification accuracy of 95 % is just out of reach at Ubisense noise, and to exceed 90 %, at least 6 tags are needed. In the upper left corner of the graph there is an area with an extremely high accuracy. It requires more tags and low noise.

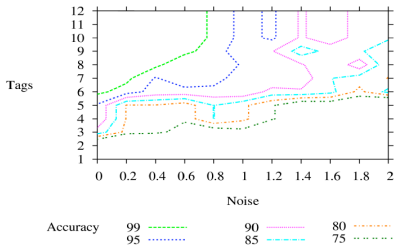

Figure 1-Classification accuracy vs. Number of tags

Conclusion

We presented the system for automatic recognition of health problems of elderly, manifesting in movement pattern. Although automatic detection of health problems is rarely addressed, our results are quite promising. We have also studied the impact of tag placement and noise level on the accuracy of detection of health problems. In general more noise and fewer tags resulted in lower accuracy, as expected. Pro for automated approach against manual is: physicians would be less overbooked with work. Con would be that elderly more appreciate human over machine assistance.