RECOGNITION AND ESTIMATION OF HUMAN LOCOMOTION WITH HIDDEN MARKOV MODELS

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INTRODUCTION: The Collaborative Research Centre "Humanoid Robots" situated at the University of Karlsruhe is aimed to construct a learning and cooperating service robot. To cope with its tasks it is necessary that the robot is able to identify diverse objects as well as different persons. Looking at stochastic models for pattern recognition Hidden Markov Models (HMMs) are described to be most suitable to classify time arranged data (Bilmes 2002). The objective of this study is to screen if the HMMs supply satisfying rates of recognition of human trajectory and angle data.

METHOD: Kinematic data of eight men and three women was captured at different walking and running speed (1.2 m/s, 3 m/s, 4 m/s, 5 m/s) on a treadmill. Data acquisition was realised with an infrared camera system with a frequency of 250Hz. For each walking/running speed there were 120 gait cycles of every test person available. The construction and training of the stochastic model was based on the gait data. Due to the fixed sequence of gait phases a HMM with a simple linear topology was chosen. Each state of the HMM represented a phase of the gait cycle. The different states were equipped with Gaussian distributions and transition probabilities to model the run of the angles observed. The HMM modelling human gait best was selected and trained with data of 17 double gait cycles for each data sequence of every test person.

RESULTS: The trained HMMs showed recognition rates from 63% to 100% for the observed data sequences for five male test persons. Highest rates could be obtained with Centre of Mass and head angles. For some test person recognition rates decreased with data of gait cycles that were captured towards the end of one run.

DISCUSSION: The high recognition rates based on kinematic data of Centre of Mass were expected due to the different mean values of the test persons according to their body height. The decrease of recognition rates that could be observed at some of the test person on late data of one run seems to be caused by acclimatisation to treadmill running. The achieved recognition rates exceed rates typical for speech recognition (Rabiner 1989). A combination of different angle data seems to promise increasing recognition rates.

CONCLUSION: The study showed that HMMs seem to be suitable to identify humans based on their kinematic gait data satisfyingly stable. According to dislocation of the Gaussian distributions it could be possible to suggest on systematic changes on patterns over changes in walking-/running speed.

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