ANALYSIS OF HUMAN MOTION WITH METHODS FROM MACHINE LEARNING

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INTRODUCTION: Usually, predefined kinematic parameters are investigated in biomechanical studies of human motion. In recent years, techniques of machine learning have been added to this field of research (Chau, 2001). In this study different dimension reduction methods like Principal Component Analysis (PCA) and Fourier Transformation (FT) are investigated as an alternative to common biomechanical approaches in motion analysis.

METHODS: Human gait in different variations of physical (full-body exhaustion) or psychological states (emotional states: happy, sad, angry, neutral) was tracked using a 6-camera VICON-system (240Hz). We chose a feature selection method which does not require information about an individual's normal gait. Instead of investigating a set of predefined features, we extracted structural and dynamical cues by PCA and FT. The procedure is leant on eigenpostures (EP) and eigenwalkers as proposed by Troje (2002). In addition nonlinear extensions, like Kernel LDA and Kernel PCA, are studied.

RESULTS: Results in recognition and classification of exhaustion (69%) and emotion (58-83% for individuals, Ø 65%) in human gait could be achieved significantly above chance. Extra success comparing to a random predictor is 36% and 52%, respectively. Applying the procedure to a statistically preselected pool of kinematic parameters leads to emotion recognition between 70-100% for individual subjects.

DISCUSSION: Applying barely feature extraction without involving expert knowledge leads to recognition rates clearly above chance level for emotional states or exhaustion in human walking. Hence, the explored algorithms give in means information which is at least 19% above guessing. Additionally, recognition rates can be improved if expert knowledge is integrated, e.g. by a previous statistical analysis which determines significant joint angles. This allows reducing the number of trained parameters in the machine learning algorithms and improves classification. Central task in future work is to enhance differentiation between hardly distinguishable motions by methods from machine learning which provide estimated probabilities for different motions involving also unknown causalities of unexpected parameters.

CONCLUSION: Techniques of machine learning showed abilities for recognition and classification of human gait just above chance. Results can be improved if expert knowledge is integrated. In a next step force-time curves of ski-jumping, measured with force plates applied to the jump-of platform (Oberstdorf, Germany), will be implemented in the explored algorithms to see whether this can enhance knowledge of technique and classify different types of performances.

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