Keio University

Thesis Abstract

No.

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Title of Thesis:

Development of Signal Processing and Machine Learning Methods for Inertial Sensor Based Motion Information Systems

Summary of Thesis:

The provision of augmented motion information is a new research problem with increasing relevance for motor skill acquisition and performance analysis in sports. Focusing on mobility and usability, this thesis demonstrates how to obtain intelligent, computer-directed motion information for diverse recipients from the measurement data of inertial sensor devices. Methods for the implementation of respective motion information systems were developed and put into use within an original data analysis framework. This framework was based on four principal procedural stages and largely consisted of signal processing methods for the inertial sensor data and machine learning methods for the recognition of motion activity. First, numeric motion data for subsequent machine data processing was collected using inertial measurement devices. Second, the information content of the acquired motion data was augmented to provide accurate and reliable kinematic motion information. Third, the augmented data was transformed so that meaningful data representations were created. Lastly, biological or artificial motion knowledge was utilized to enable the retrieval of relevant motion properties and its subsequent provision to the user. Every computational stage required sophisticated algorithms that were illustrated with practical motion data from rehabilitation, ski jumping and every day motion actions. The latter processing steps were furthermore designed under two variant sample applications: the provision of auditive feedback by means of movement sonification and the provision of performance scores by means of motion evaluation. To date, no other work is known that would have used computational methods on actual sport motion data in a similarly universal, yet applicable way. Therefore, this work constitutes an important contribution to the future implementation of motion analysis and training software tools that support multiple aspects of a motion performance. Especially for judging-based sports, the presented intelligent style assessment could provide fundamental and unique information to increase objectivity and measurability of the final competition scores.

Keywords:

computational motion analysis, augmented motion feedback, body sensor networks, inertial motion capturing, motion signal processing, motion information retrieval