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Human Motion Analysis Tools

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Resumo

Análise de movimento é actualmente um tópico de pesquisa bastante activo nas áreas da Visão por Computador, Computação Gráfica e Biomecânica, devido à sua aplicabilidade num vasto espectro de aplicações em diversas áreas. Com este trabalho pretendemos apresentar um detalhado, abrangente e atualizado estudo sobre aplicações de análise e/ou de simulação de movimento, que têm sido desenvolvidas tanto pela comunidade científica como por entidades comerciais. O principal contributo deste estudo, além da listagem abrangente de ferramentas de análise de movimento, é a apresentação de um esquema eficaz para classificar e comparar ferramentas de simulação e de análise de movimento.

Abstract

Motion analysis is currently an active research topic in Computational Vision, Computer Graphics, and Biomechanics mainly due to its applicability into a wide spectrum of relevant applications in many areas. This work intends to present a detailed, broad and up to date survey on motion and/or simulation analysis software packages that have been developed both by the scientific community and commercial entities, to be used in the field of biomechanics. The main contribution of this study, beyond the comprehensive listing of mo- tion analysis tools, is the presentation of an effective framework to classify and compare motion simulation and analysis tools.

Keywords

Motion analysis, motion simulation.

1. INTRODUCTION

Motion analysis is a multidisciplinary research topic dedicated to the detection, tracking and understanding the physical behavior of moving entities. Although this is not a new topic of research, it is very active and receives considerable attention within the research communities of Computational Vision, Computer Graphics and Biomechanics [Gavrila99, Dariush03, Poppe07]. Over the latest years, due to the technological evolutions in personal computers, in video analysis, and in laboratory data acquisition hardware, major contributions have been addressed to develop more robust, more accurate and faster solutions. Many relevant engineering software applications have been developed with the purpose of analyzing and/or simulating human motion. The usage of these tools becomes fundamental in various areas of movement science.

This work presents ongoing work towards a detailed, broad, and up to date survey on human motion and/or simulation analysis software packages that have been developed both by the scientific community and commercial entities to be used in the field of biomechanics. The main contribution of this study, beyond the comprehensive listing of motion analysis tools, is the presentation of an effective framework to classify and compare motion simulation and analysis tools. For the mentioned purpose a set of relevant features is identified and described. As the main outcome, the surveyed tools are classified in respect to the proposed framework and enabling a comparative overview of all the analyzed tools is summarized in a table.

2. HUMAN MOTION ANALYSIS AND SIMULATION

The analysis of human actions is an essential task for a wide range of applications which can be classified under three different groups: surveillance, control and analysis [Moeslund06]. Our work focuses on the class of applications used for analysis. In these type of applications the motion data is reduced to relevant features for comparison and classification purposes. In sports, for example, the biomechanical analysis of the movements of athletes can help them to understand and improve their performances or even facilitate the recovery process after injuries. In ergonomics, the motion data is used to study phenomena related to human postures during their occupation , or to design new office furniture, new products and new workstations. In medicine, the study of human motion can be

also extremely valuable. A good understanding of the human motion, taking into account the biomechanical foundations and the physiology of the elements involved, is extremely important. It can help to reveal the distinct patterns that classify a particular movement. For example, stroke victims exhibit movements that are distinctive from healthy people. With effective classifiers it's possible to have quicker diagnoses and more effective rehabilitation techniques that specifically address the needs of the individual patient.

Simulations using motion data can make predictions of movements based on changes to muscles, positions, and forces. In fact, simulations offer many advantages in respect to physical experiments. They can be used to evaluate and analyze the effects of a hypothetical surgery, to design new products and processes, helping to reduce the number of physical prototypes, as well as expenses and the associated risk [Garcia02].

3. PROPOSED CLASSIFICATION FRAMEWORK

Once selected the most cited motion analysis tools within the scientific literature, we defined a set of features to describe them. This include a set of generic features, a set of modeling capabilities features, a set of data acquisition features, and a set of analysis and simulation features.

3.1. Generic Features

The first set of features attempts to characterize the tool in a generic manner. It comprises: i. the tool latest version and its release date, giving a sense of maturity of the application;ii. if there is an active user community sharing knowledge and expertise using discussion foruns, wikis or other collaboartive tools; iii. the information specifying whether the tool began as an academic project or not, and in case of affirmative, indicate the seminal paper (whenever possible); iv. the software availability, i.e., whether it is a free or a commercial product; v. openness of the software architectures, in particular what are, if available, the mechanisms to extend the tool with custom functionalities, as for instance: open source, software development kits (SDK) and application programming interfaces (API), plugin developments or scripting; vi. the ability to export the resulting data from motion analysis, allowing further analysis using other tools; vii. the ability to store the patients profile as well as their trials and sessions for easy comparison of "before and after" scenarios.

3.2. Modeling Features

The second set of features describe the modeling capabilities of each tool, indicating: i. the possibility to create and/or edit models; ii. if the tool has its own collection of models that can be used. it is very important that a software solution enables users to develop and edit their own models, and that they have available a set of predefined whole-body and/or body-part models.

3.3. Data Acquisition Features

The third set describes how and what data can be acquired, mentioning: i. if the tool has a native, external or absent motion capture system; ii. if the tool imports analogue data, identifying all the sources of the data (C3D/EMG/force plates). The synchronization of all signals allows technical personnel to evaluate simultaneously how the patient moves the articulations, uses his or her muscles and exchanges forces with the ground during the stride cycle.

3.4. Analysis Features

The analysis set of features refers to: i. the dimensionality of the motion analysis (2D, 3D or both); ii. the timing that the analysis occurs (real time, offline or both);

3.5. Simulation Features

The simulation set of features comprises: i. a flag indicating whether it is possible or not to simulate the human movement.; ii. the dimensionality of the motion simulation (2D, 3D or both);

4. CONCLUSIONS AND FUTURE WORK

Human Motion Analysis and Simulation (HMAS) is, since long time ago, an important and multidisciplinary research topic. Applications vary from diverse areas as medical, biomechanics, sports performance and human machine interaction. Recent technological developments allow to provide researchers with automated and semi automated tools in order to model, analyze or simulate human motion. Several open problems, such as marker-less tracking, interactive and real time operation, full 3D acquisition, uncontrolled environments (lighting, occlusions, etc.) still remain. This work presents the state of the art in respect to automated tools in HMAS and introduces our perspective on how HMAS tools can be classified and compared. A logical, structured and feature oriented classification framework is available at http://bit.ly/HUMANTOOLS.

As future work, and beyond keeping it up-to-date, we intend to extend the herein presented framework in respect to some particular technologies and approaches and refine it accordingly towards a full taxonomy of HMAS Tools.

5. REFERENCES

[Dariush03] Behzad Dariush. Human motion analysis for biomechanics and biomedicine. *Machine Vision And Applications*, 14:202–205, 2003.

[Garcia02] J. M. Garcia, M. Doblare, and J. Cegonino. Bone remodelling simulation: a tool for implant design. *Computational Materials Science*, 25:100–114, 2002.

[Gavrila99] D. M. Gavrila. The visual analysis of human movement: A survey. *Computer Vision and Image Understanding*, 73:82–98, 1999.

[Moeslund06] Thomas B. Moeslund and Adrian Hilton. A survey of advances in vision-based human motion capture and analysis. *Computer Vision and Image Understanding*, 104(90-126), 2006.

[Poppe07] Ronald Poppe. Vision-based human motion analysis: An overview. *Computer Vision and Image Understanding*, 108:4–18, 2007.