Digital Human Model Applied to Training and Education in Sports

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ABSTRACT

The purpose of the study is to present a 3D digital interactive environment that is being developed in a game engine software to work with 3D DHM applied to training and education on Sports. This platform is being developed considering the need to analyze data from the same athletes' movements being repeated in different time or even to compare athletes' movements with different skill levels. The main 3D digital platform advantage is its flexibility to handle motion capture data from different MOCAP systems in order to facilitate kinematic analysis by users of low cost motion capture systems. Another important advantage is its portability that allows it to be used in different hardware platforms, as tablets and cell phones. The 3D platform development followed some specific steps, which make it possible not only to visualize the performed motion but also make the interaction between the user and the 3D character. The first step consists on the automatic reconstruction of the 3D character body segments based on motion capture data. The visual representation has as benefit that reduces noise that may be generated in the process of retargeting the motion capture data to a specific rig and character that differs from the actual bone structure original data. The visual representation is generated based on laser scanning data. This makes the representation to be a precise copy of the original bone position and structure of the athlete' specific movement that is being captured. The second step is to link each bone segment by generating a 3D model with a collision area that is necessary for future interaction with the user. After those steps, the user can select to track and generate data of a specific body segment; to play/pause the athlete movement and to draw graphs of segmental angles, joint angles and angular velocity. This functionality is still under development and test. The first application of the 3D digital platform was the movement analysis of high and low skill level Jiu-Jitsu athletes. This analysis allowed an improvement on the athletes' performance and skills. In the future the integration between the 3D scanned athlete's model and a virtual environment will allow to develop a virtual simulator that can be applied to education, training and entertainment.

Keywords: Digital human modeling, Training, Education, Jiu-jitsu

INTRODUCTION

Digital Human Model (DHM) is a digital human representation in the 3D space that can be moved and manipulated to simulate real and accurate movements of people (Guimarães et al., 2013). Digital human modeling is a fast growing area that bridges computer-aided engineering, design, human factors, applied ergonomics and sports coaching and training (Anja Naumann and Matthias Rötting, 2007). The improvement on modeling software and computer technology have allowed digital human modeling to be simulated in a digital environment. Digital human modeling and simulation play an important role in product design, prototyping, manufacturing, sports biomechanics

and many other areas (Guimarães et al, 2010).
An example of DHM in sports improvement was a study that had the primary aim to determine the efficacy of three-dimensional (3D) musculoskeletal modeling in evaluating an resistance-training equipment design (an seated row resistance-training machine). A 3D full-body musculoskeletal model was created using LifeModeler software and incorporated into a multibody dynamics model of the seated row resistance machine generated in MSC ADAMS software (K Nolte, P E Krüger, P S Els, H W Nolte, 2013). With DHM it was possible to simulate musculoskeletal human models interacting with mechanical systems that−allowed many aspects concerning the effects of the resistance-training equipment on the body being studied.
The term “serious games” describes video games designed specifically for training and education (in terms of learning and practice) (Annetta, 2010; Steinmetez and Göbel, 2012). A subset of educational serious gaming focuses on training, where users need to acquire a specific competence or built up a particular set of skills. Serious games provide extensive opportunities for drill and practice and is a very promising tool for sports training. The idea of serious games is to use the motivation inherited in games for other purposes like learning, sports training, rehabilitation exercises, or even advertisement or opinion forming.
Serious games are designed to solve real life problems through environment visualization and simulation (Senerirathne et al., 2011). The integration of technology within educational settings is far from a new concept. Technological innovations have been frequently implemented in attempts to enhance the learning experience. Some technology as inertial sensors, magnetometers, GPS and wireless technologies, or a combination of such devices can improve detailed activity information, sports biomechanics and performance measures data extracted in order to enrich coach and technique evaluation (James et al, 2012).
The purpose of this paper is to present a 3D digital interactive environment that-is being developed in a game engine software to work with 3D DHM applied to sports training and education.

3D INTERATIVE PLATAFORM FRAMEWORK

The Ergonomics Laboratory of the National Institute of Technology and the Ergon Projects Enterprise have developed "serious games" platforms and simulation environments applied to ergonomic work analysis and new ergonomic design. The goal of these simulations has been to help designers and employees to understand and implement ergonomic concepts work environment design. Considering that experience, the Ergonomics Laboratory team and Ergon decided to apply that knowledge to sports training, in special to Combat sports. The efforts are being conducted to the development of an 3D interactive environment system that comprises basic jiu-jitsu movements and its definition based on experts Jiu-jitsu players knowledge and on biomechanics analysis. That system consists of Basic System and modular tools described below (see figure 1):

- Analysis: Allow to get and to record- the "bone" data graph ou diagram or the join movement in 3D
- E-Book – consisting of text, images of Jiu-jitsu sport, that can be readable on computers or other electronic devices
- Reports: Return reports with graphs and diagram for printing or saving
- Export Data: Allow to export the RAW data to XML or other exchange data type.

Figure 1: Flow chart

The Analysis stage comprised of two steps before data input in the 3D digital interactive environment:

1º step: athletes scanning and motion capture conducted on the Ergonomics Laboratory. First, the athlete was scanned in a *Cyberware WBX 3D* whole body scanner (Figure 2 and 3), then the scan file was processed to minimize the number of polygons and to close holes – the retopology process (Lerch et al., 2007). For the motion capture session the athlete wore a special suit from *Xsens* with 17 inertial sensors (Figure 4). Then the athlete selected and defined some basic jiu-jitsu movements that were captured (Figure 5)

Figure 2: Scanning process

Figure 3: Saving the scan file for retopology process

https://openaccess.cms-conferences.org/#/publications/book/978-1-4951-2094-7

Figure 4. Athlete using motion capture sensors

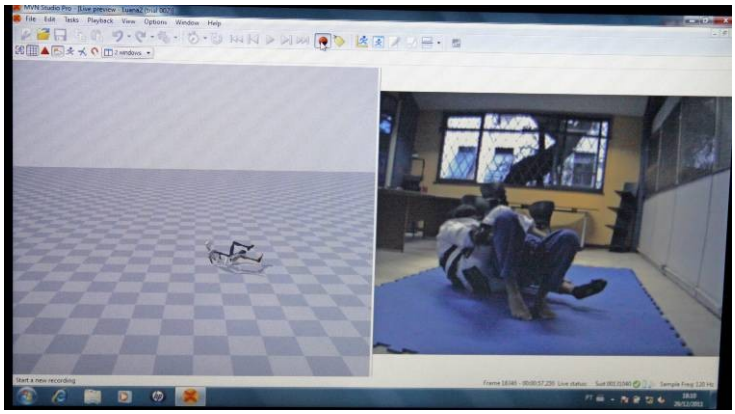

Figure 5. Motion capture session

2º step: 3D Simulation and Modeling – the data captured from XSENS MOCAP and the 3D DHM data from scanning process were incorporated by our virtual platform that was developed as a "serious game" interactive 3D software . The visual representation of the 3DHM at the platform was generated based on XSENS MOCAP data, following position and dimension of bone segments of the virtual body. That makes the visual representation an accurate copy of the original bone position and of the specific actor's movements being captured.

This stage covered the development of an interactive platform using Unity3D game engine. That platform was developed considering the need to analyze data from different athletes movements being repeated in different moments (Kinematics analysis) (Figure 6). The data analysis will allow the kinematic data to be visualized by means of graphics – angular and linear position, angular displacement, and angular velocity. The graphics information can also be visualized with the 3D digital human model. This kind of visualization makes it easy to analyze the data with athletes and coaches.

E-Book and Reports Stages complete the interactive platform (Figure 7), The E-book features an entry corresponding to the movement currently under analysis (Figure 6) while the Report Module export the Analisys Results to a exchangable and readable data type as a spreadsheet.

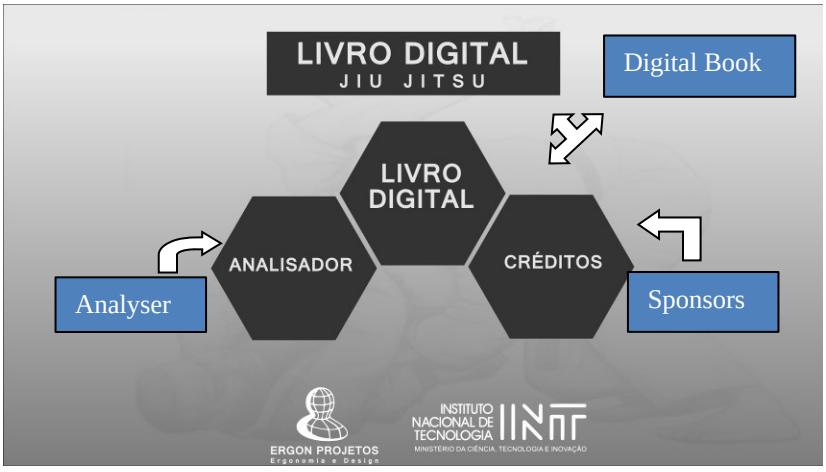

Figure 6. System home screen

https://openaccess.cms-conferences.org/#/publications/book/978-1-4951-2094-7

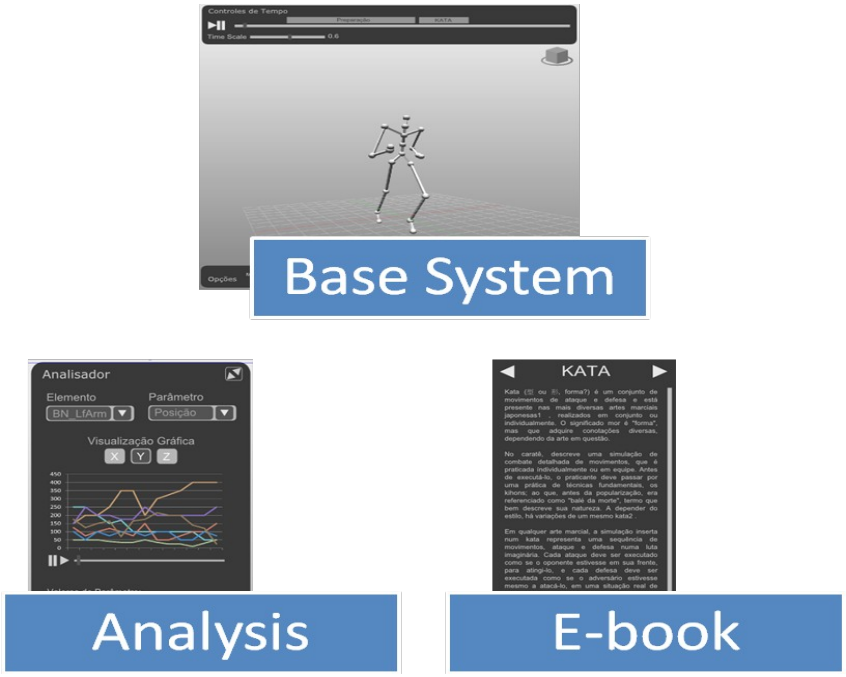

Figure 7. Example of the proposal flow chart applied to a 3D interactive environment

CONCLUSIONS

The 3D digital interactive environment is still under development. Its analysis will allow to study and to improve athletes' performance through teaching. In the future the integration between a 3D scanned athlete's model and a virtual environment will enable the development of a virtual simulator that can be applied to education, training and entertainment.

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