STREACKER

Skeletal Tracking Enhanced with Anatomically Correct Kinematics for Exergames and Rehabilitation

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TEAM

PI in Portugal:
Daniel Simões Lopes, Instituto de Engenharia de Sistemas e Computadores, Investigação e Desenvolvimento em Lisboa (INESC ID/INESC/IST/ULisboa)

PI at UT Austin:
Richard Neptune, Walker Department of Mechanical Engineering, Cockrell School of Engineering

Other partnering organizations:
Mechanical Engineering Institute (IDMEC)
Hospital Professor Doutor Fernando Fonseca, EPE

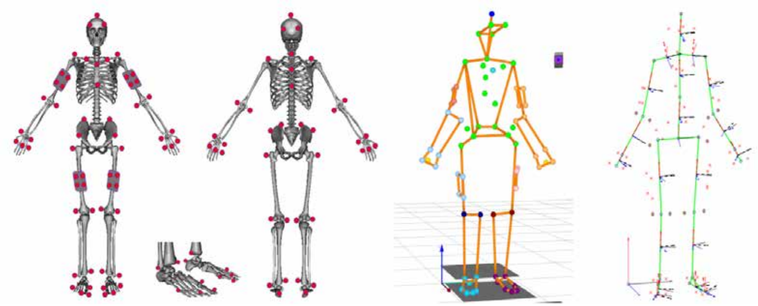
ADVANCED COMPUTING

Background

This project aims to develop and implement a machine learning algorithm capable of estimating anatomically correct body segment rotations based on minimal marker-sets, namely, stick-figures acquired from motion capture systems such as the Kinect sensor, Qualisys or Vicon.
More specifically, the ill-posed problem at hands consists of estimating the 6th degree of freedom (rolling angle) from only 2 non-coincident points that belong to a rigid body (body segment).

Approach/Methodology

At first, we started by identifying current rehabilitation and exergame practices that would greatly benefit from the proposed algorithm. Through a task analysis, relevant feedback was gathered next to biomechanics and physiotherapists.
Afterwards, we recruited several participants to perform a battery of movements, each set of movements was then acquired, processed, and stored in a database of motion capture data.
After a more thorough literature review on current machine/deep learning applied in motion processing and biomechanics, we opted for a supervised learning regression to estimate longitudinal rotations during the time, which was implemented in Python (Jupyter).
Experimental data from the database was used as training and test sets. Finally, a statistical analysis was performed to verify the amount of error (simulated data vs. experimental data) and to validate the algorithm.



Implementation Challenges

The main challenge we faced was to find a decent, full-time postdoc capable to formulate, implement, train and test the neural network (i.e., machine learning algorithm). Fortunately, we had the support of a Researcher Assistant (‘Investigador Contractado’) from INESC-ID Lisboa, that was included to the project as a research member.

Main Findings

The main outcome of our work consists of the positive results obtained from the machine learning algorithm: through a supervised learning approach, we were able to estimate the longitudinal rotation angles that revealed to be, in general, anatomically correct with a maximum error that is near 10 degrees.
Note that we are dealing with an ill-posed problem as the stick-figure data offers an incomplete amount of data to estimate the missing degree of freedom.

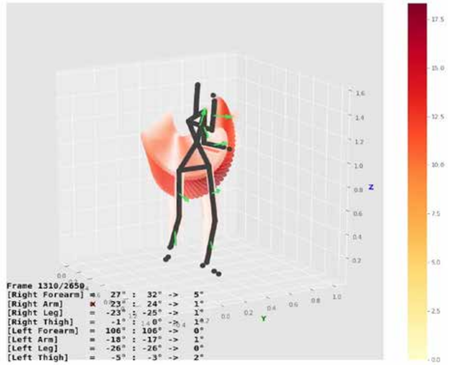
Expected Impact

The machine learning algorithm will augment current motion capture systems that are used not only in Gait Labs, but also in exergames and rehabilitation settings.
In particular, motion capture systems that are ‘markerless’ (VicoVR, Kinect) or perform full body tracking with a single RGB-camera (PoseNet), which do not require placing optical markers upon the user, will benefit most from our algorithm as they resort on a minimal set stick-figure model that is similar to the one we have considered.

Project Highlights

We have built a motion database that will be made freely available once the main paper (the one that reports the machine learning algorithm) is published.

We implemented a machine learning algorithm to estimate anatomically correct longitudinal rotations that will be made freely available once the main paper (the one that reports the machine learning algorithm) is published.



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