Learning dynamics of high-level sports from automatic video analysis

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KeyWord : sport, motion analysis, computer vision, machine learning, biomechanics.

Context: The LJK laboratory and INRIA Grenoble center supervise the project PerfAnalytics (http://perfanalytics.fr), a large project on automatic video analysis for scientific and technical support of French athletes for their preparation to the 2024 Olympics Games. The goal of this project is to develop innovative tools to quantify different aspects of performance in high-level sport using recent advances in computer vision and machine learning. As a specific part of the project, a connection with biomechanics is developed to improve the accuracy of the description of gesture quantification.

Work description: From preliminary work, a workflow has been developed to create a personalized 3D geometrical model of the athletes from videos. Such a model includes both kinematic (joints location) and dynamic aspects (mass and inertia of body segment). The extraction of biomechanical parameters such as joint torque is a valuable insight for quantifying the performance of an athlete. The traditional workflow in biomechanics is to predict such net torque at joints from the 3D kinematics of the limbs and the external forces explicitly measured with force sensors (inverse dynamics). Existing methods can extract 3D kinematics from video only but, in the context of sport practice, it is usually difficult to insert force sensors. The goal of this internship is thus to participate in the on-going study to predict directly the external forces applied by the body in motion from the 3D trajectories of its limbs only [1]. This problem of force prediction will be studied in the specific context of the PerfAnalytics project where motion is computed from a video-based system [2,3]. Using an existing dataset of motion and force measurement for standards activity such as walking, as well as sport climbing, the goal of the internship is to show if such a prediction of forces from 3D motion extracted from video is stable enough using a machine learning approach for time series.

Expected skills:

- strong programming skills in Python or C++
- knowledge of machine learning
- some expertise in mechanical modeling will be a plus

Environment: The internship will take place at the LJK laboratory in Saint-Martin d'Hères (next to Grenoble), under the supervision of Lionel Reveret (INRIA). The allowance will be 550 euros per month. The candidate will participate in the global project PerfAnalytics for preparation of French athletes to Paris 2024 Olympics games. Candidates must send application and CV to lionel.reveret@inria.fr

Reference:

[1] Muller A., Pontonnier C., Dumont G., Motion-based prediction of hands and feet contact efforts during asymmetric handling tasks, IEEE Transactions on Biomedical Engineering, 2019

[2] Rempe D., Guibas L. J., Hertzmann A., Russell B., Villegas R. Yang J., Contact and Human Dynamics from Monocular Video, ECCV 2020.

[3] Zongmian Li, Jiri Sedlar, Justin Carpentier, Ivan Laptev, Nicolas Mansard and Josef Sivic, Estimating 3D Motion and Forces of Person-Object Interactions from Monocular Video, 2019 IEEE/CVF, Conference on Computer Vision and Pattern Recognition (CVPR'19)