PhD fellowship in Robotics

Title: Force capability biomechanical indices

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Job offer description

Motor tasks imply the application of functional forces on the environment by the hand or the foot. From a biomechanical point of view, the ability of one individual to generate such forces efficiently depends on the adopted posture and on the musculo-skeletal characteristics. For a given posture, the assessment of the capacity of force generation in all Cartesian directions may have interesting applications. Indeed, it may be useful for the evaluation of physical abilities for ergonomic and rehabilitation applications. More generally, it may contribute to a better understanding of the human motricity. The existing biomechanical indices of force or torque capability are limited to a particular direction in Cartesian space or to a particular joint axis and therefore do not give a global view of the subject abilities. In this framework, the aim of this thesis will be to develop and propose global indices that characterize the force capabilities in all Cartesian directions by resorting to formalisms coming from the robotics field. Indeed, the so called ellipsoid and polytope of force seem to be particularly suited because they can assess force capabilities in all directions from hypotheses on joint torque capabilities.

The aim of the thesis will be to apply the force polytope formalisms to the field of biomechanics. From motion capture data and a biomechanical model of the upper-limb, the proposed indices will take into account the difference between the joint axes and movement directions in term of maximum isometric torque production. For this purpose, data on maximum isometric joint torque at the shoulder, elbow, and wrist will be measured by an appropriate system (Biodex) and integrated into the indices definition.

The presence of multiarticular muscles conducts to the fact the maximum torque for a particular joint axis depends on the posture of other joints. Therefore, the first part of the thesis will consist in defining the appropriate data and procedure to evaluate the isometric torque capabilities in the arm workspace from measurements made at chosen postures.

The second part will consist in evaluating the force ellipsoid and force polytope from experimental data (motion capture and biodex datat) and validate the indices from the measurement of isometric force production in various directions at the hand with a force sensor.

The last part will consist in evaluating the defined parameters on a task of daily living in the framework of rehabilitation.

The developed indices may find interesting applications in the framework of human motricity evaluation for ergonomic and rehabilitation applications but also may contribute to the optimisation of tools and postures in relation to a particular task. Further development will consist in using musculoskeletal models to assess the force capabilities taking into account synergetic functioning of the muscles.

Skills and profile

The candidate should have a good background in applied mathematics and/or mechanics. knowledge in robotics and biomechanism would be a plus. Good programming skills is required.

Benefits

Duration: 36 months

Salary:for the first and second year around 1957€ gross/month

Monthly salary after taxes : around 1597€ (medical insurance included).

For the third year around 2059 € gross/month

Monthly salary after taxes : around 1680 € (medical insurance included)

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