

Postdoctoral position

Musculoskeletal modeling and machine learning to quantify the biomechanical activity of manual wheelchair users

Context

Locomotion with a manual wheelchair (MWC) generates an important stress on the upper limbs of manual wheelchair users (MWU), that varies according to the environment. To assist MWU to choose the path that best preserve their upper limbs, a cost based on the biomechanical demand of the successive situations along the possible paths must be attributed. In the current accessibility standards, obstacles have no graduation and are only marked as crossable or not. This reflects neither the variety of the situations, nor the link between accessibility and physical or technical abilities of the MWU. To go beyond these limitations, this project aims at defining biomechanical costs attributed to various environmental situations and implementing them in optimal path selection algorithms. This would provide individualized paths to MWU considering their own capacities. To do so, a musculoskeletal model will be developed to quantify biomechanical costs. These costs will be computed for various situations, reproduced in a realistic MWC locomotion simulator developed in the framework of this proposal. Such a project will provide original and useful data for accessibility evaluation, urban development planning and MWC assistance adaptation. It will be the basis for further MWU evaluation and paths characterization to provide personalized cost-optimal paths.

The project CapaCITIES, granted by the French National Research Agency, is a collaborative project involving the:

- Centre d'Etudes et de Recherche sur l'Appareillage des Handicapés (CERAH, Institution Nationale des Invalides)
- MimeTIC Team (IRISA/M2S/INRIA joint team, Rennes France)
- Institut de Biomécanique Humaine Georges Charpak (IBHGC, Arts et Métiers Sciences et Technologies)
- Laboratoire d'Automatique, de Mécanique et d'informatique industrielle et humaine (LAMIH, Université Polytechnique des Hauts de France)

Objective

A postdoctoral fellow will be hired to work full-time on the project for 24 months with a mobility between two labs (12 months at IRISA, Rennes, France, followed by 12 months at CERAH, Créteil, France). He (she) will be involved in personalized musculoskeletal modeling and simulation, experiments, and data preparation to provide the biomechanical costs of WCH locomotion.

Main activities

First, he/she will be involved in the development of a comprehensive musculoskeletal model of the upper limb and its interaction with a wheelchair, in collaboration with a PhD student already hired on the project. The postdoctoral fellow will have to implement specific interaction rules between the user and the wheelchair inside such simulations, involving contact representation and detection as well as interaction forces prediction.

Second, he/she will be involved in the model scaling issues relative to the model proposed above. For the scaling of the user muscle capacities in specific configurations, he/she will develop specific data-based scaling methods.

Third, he/she will focus on the data mining of experimental data gathered along the project (he/she will also be involved in these experimentations), to be applied to the model developed above. From the parameters computed with this model, the postdoctoral fellow will develop automatic extraction methods of features of interest able to characterize the wheelchair locomotion task with regard to the conditions. This work will be a fundamental part of the development of an aggregative biomechanical score representative of the wheelchair locomotion for many situations.

Skills

The candidates ideally have a significant experience in musculoskeletal modeling, and a certified background in machine learning. A strong experience in biomechanical data processing and experimentations is also relevant for this work.

Advantages

A salary of 2000€ net per month will be proposed for the 24 months of contract. Flexible organization of working hours. Professional equipment available (videoconferencing, loan of computer equipment, etc.). Social, cultural and sports events and activities. Access to vocational training. Social security coverage.

General Information

For the first 12 months, this research topic will be carried out in **Rennes**, the capital of Brittany and the tenth largest city in France, with a metropolitan area of about 720,000 inhabitants. Moreover, with more than 66,000 students, Rennes is also the eighth-largest university campus of France and it has the 2nd highest concentration of digital and ICT firms in France after Paris. Rennes is also known to be one of the most festive and lively cities of France, home of several music and culture festivals. In 2018, the newspaper "L'Express" named Rennes as "the most liveable city in France". The candidate will join the Inria MimeTIC team (<https://team.inria.fr/mimetic/>), internationally recognized for its multidisciplinary approach to analyse, model and synthesize motion. The candidate will be integrated into a group working on motion and musculoskeletal analysis. The candidate will also have access to the experimental platform [Immermove](#) which offer a high-tech set-up to perform user experimentations and measure motion (motion capture, EMG, force plates, isokinetic ergometer).

For the second 12 months, the project will be carried out in the CERAH research department in Créteil (France) in close collaboration with a PhD candidate hired at Institut de Biomécanique Humaine Georges Charpak located in Paris. The CERAH (centre d'étude et de recherche sur l'appareillage des handicapés) is a study and research center focusing on people with disabilities, and which is part of the Institution Nationale des Invalides. One of the missions of the center is to certify assistive devices and prosthetics. The center also gets part in applied research of many issues related to motor deficiencies and functional substitution products. Its objective is the development of knowledge allowing the improvement of care, health and quality of life of people with motor impairment. CERAH's research aims at the production and distribution of knowledge and technical solutions targeted at the entire population of the physical medicine and rehabilitation professionals, the users, and the scientific community.

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