French Polytech network form for PhD Research Grants from the China Scholarship Council

This document describes one of the PhD subjects proposed by the French Polytech network. The network is composed of 15 engineering schools/universities. The document also provides information about the supervisor. Please contact the PhD supervisor by email for further information regarding your application.

Supervisor information	
Family name	Tabourot
First name	Laurent
Email	Laurent.tabourot@univ-smb.fr
Web reference	www.linkedin.com/in/laurent-tabourot
Lab name	Système et Matériaux pour la MEcatronique (SYMME)
Lab web site	Symme.univ-smb.fr
Polytech name	Polytech Annecy Chambéry
University name	Université Savoie Mont Blanc
Country	France

PhD information	
Title	Biomechanical Modeling of the Ankle and Its Role in Postural Control: Towards Innovative Clinical and Preventive Application
Main topics regards to CSC list (3 topics at maximum)	Biomedical engineering

Required skills in science and engineering	Biomechanics Expertise. In-depth understanding of biomechanical principles, particularly joint and soft tissue mechanics. Experience in modeling and simulating biomechanical systems. Knowledge of Neuromuscular Systems. Familiarity with neuromuscular responses, reflexes, and proprioceptive adjustments. Understanding of the interactions between the nervous system and the musculoskeletal system. Proficiency in Medical Imaging Techniques. Experience with dynamometry, computed tomography, and other advanced imaging techniques. Ability to analyze and interpret imaging data for biomechanical applications. Skills in Computer Modeling and Simulation. Expertise in using modeling and simulation software such as MATLAB and OpenSim. Programming skills to develop and refine simulation models. Statistical Analysis Competence. Experience in statistical and correlational analysis to interpret experimental data. Ability to work with varied data samples and perform rigorous analyses. Knowledge in Prototyping and Development of Biomechanical Devices. Skills in designing and validating biomechanical prototypes. Experience in instrumentation and developing devices for clinical or rehabilitative applications. Research and Scientific Writing Skills. Proficiency in scientific writing to document research findings and draft high-quality articles. Ability to conduct comprehensive literature reviews and identify gaps in current knowledge.

	Project Management Abilities. Capability to manage different phases of a research project, from planning to execution and dissemination of results. Strong organizational skills and the ability to work independently and as part of a team. Communication and Interdisciplinary Collaboration. Ability to effectively communicate technical and scientific concepts to a diverse audience. Experience collaborating with healthcare professionals, engineers, and other researchers in related fields. These skills will enable the candidate to successfully carry out various stages of the thesis, from data acquisition and analysis to modeling and prototype development, while significantly contributing to advancements in postural control and innovative clinical applications.

Subject description (two pages maximum including biblio)

Introduction

Postural control, fundamental to stability in the standing position, relies on a complex interaction between biomechanical mechanisms and neuromuscular responses. The study of ankle mechanics plays a crucial role in these dynamics, serving as a major pivot point in the maintenance of balance.

Overview of Ankle Mechanics in Postural Control

The ankle is a key joint involved in the regulation of the center of mass and postural stabilization. Research highlights the importance of ankle reflexes, rapid neuromuscular responses, and proprioceptive adjustments in compensating for postural disturbances.

Advances in medical imaging, particularly the use of dynamometry and computed tomography, allow for a detailed analysis of the structure and mechanics of the ankle joint, illuminating the forces and stresses involved in maintaining postural stability. Despite these advancements, there remain gaps in the precise modeling of biomechanical mechanisms specific to the ankle in relation to postural control. The Symme Laboratory has conducted an initial thesis providing a convincing analytical framework that could

address some of these gaps. This thesis aims to build upon this framework by focusing on a detailed analysis of ankle mechanics and its implications for postural stability. It will involve the modeling and implementation of a bio-inspired ankle using the proposed representation.

Objectives

- *Biomechanical Modeling*. Develop detailed models of ankle joint mechanics to simulate forces and tensions during postural control.
- *Analysis of Neuromuscular Responses*. Study the reflexes and specific muscular responses of the ankle in reaction to postural perturbations.
- *Data Integration*. Correlate biomechanical data with neuromuscular responses to understand the specific contribution of the ankle to postural control.
- *Prototype Development*. Validate modeling hypotheses on a prototype instrumented ankle. This mock-up could be a prelude to developing a biomechanical ankle for prosthetic applications.

Method

- Utilize motion capture and electromyography to obtain precise data on ankle movements and muscle activation.
- Employ computer modeling to simulate joint forces and muscle tensions involved in maintaining balance (using MATLAB, OpenSim).
- Conduct statistical and correlational analyses to establish links between joint mechanics and neuromuscular responses (testing on specific samples of individuals).

Envisioned Applications

- Develop rehabilitation protocols targeting specific ankle mechanics to improve postural control in individuals with balance disorders.
- Identify ankle-specific biomarkers to assess fall risk and design appropriate preventive interventions.
- Contribute to the optimization of biomechanical assistive devices to enhance postural stability.

Conclusion

This thesis focuses on the mechanical analysis of the ankle in postural control, aiming to fill current gaps in understanding its specific role and to open up prospects for innovative clinical and preventive applications.

_____

This thesis proposes an approach focusing on the mechanics of the ankle in postural control, combining aspects of biomechanical modelling and analysis of neuromuscular responses to gain a better understanding of the specific contribution of the ankle to stability in the standing position.

Essential references on this topics (priority order)

Winter DA, Patla AE, Prince F, Ishac M, Gielo-Perczak K. Stiffness control of balance in quiet standing. J Neurophysiol. 1998 Sep;80(3):1211-21. doi: 10.1152/jn.1998.80.3.1211

Peterka RJ, Loughlin PJ. Dynamic regulation of sensorimotor integration in human postural control. J Neurophysiol. 2004 Jan;91(1):410-23. doi: 10.1152/jn.00516.2003. Epub 2003 Sep 17

Gatev P, Thomas S, Kepple T, Hallett M. Feedforward ankle strategy of balance during quiet stance in adults. J Physiol. 1999 Feb 1;514 (Pt 3)(Pt 3):915-28. doi: 10.1111/j.1469-7793.1999.915ad.x