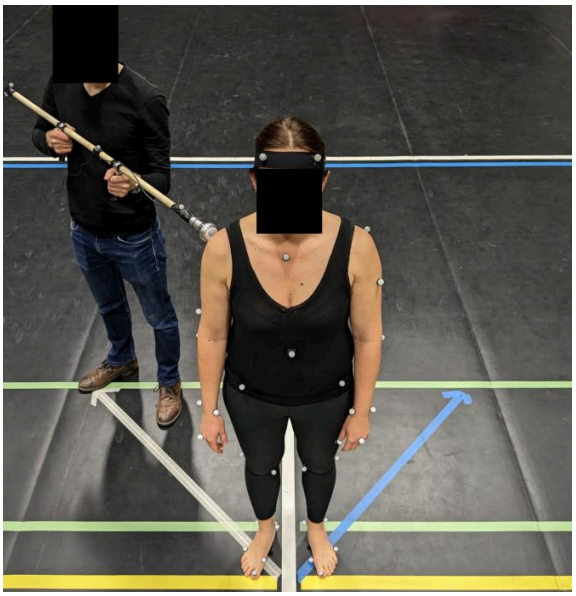
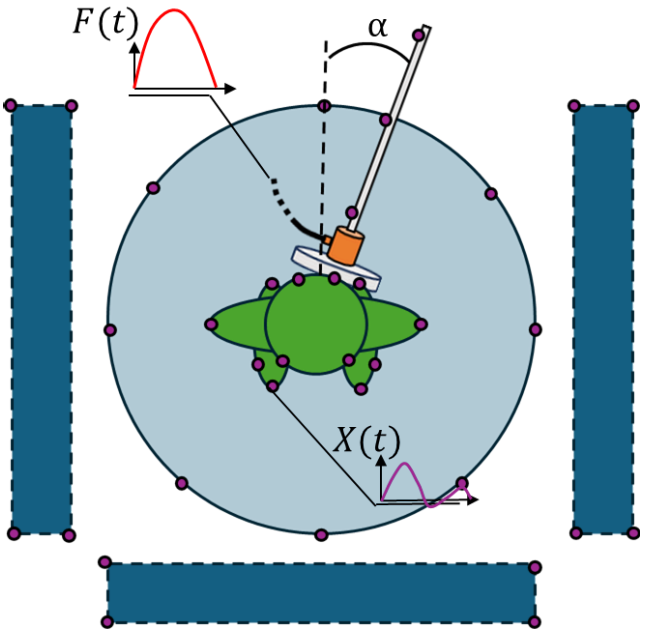
Don’t Let Me Down! Stepping and Upper Limb Balance Recovery Strategies under Push Perturbation





Left hand side: Picture of the experimental setup used in (Chatagnon et al., 2023). Right hand side: A very sophisticated way to push people against walls with an instrumented pusher.The setup is similar to (Chatagnon et al., 2023), with the addition of walls being placed at a controlled distance of the subject. Purple dots are motion capture markers and the orange cylinder represents the force sensor.

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Location of the Internship: Inria Centre de l’Université de Rennes, Combo and VirtUs teams

Keywords: Balance recovery, fall, recovery strategies, biomechanics

Context:
This internship is a follow up of the research topics addressed during the European project CrowdDNA about balance recovery in densely populated environments. In particular, we would like to investigate the role of the upper limbs in the recovery process following external perturbations. This internship would be held in collaboration between the Combo and VirtUs teams at Inria Rennes (Charles Pontonnier, Anne-Hélène Olivier) and Gustave Eiffel University in Lyon (Thomas Robert). The intern will also be supervised by Thomas Chatagnon (Forschungszentrum Jülich, Germany) who performed an experimental assessment of the standing balance recovery following push perturbations during his Phd (Chatagnon 2023) .

Multiple experiments to study standing balance following pushes have been performed during the CrowdDNA project, either with single individuals (Chatagnon et al., 2023) or with multiple individuals in crowded environments (Feldmann & Adrian, 2023; Feldmann et al. 2023, Chatagnon 2023). Studies about balance recovery following these experiments focused on stepping strategies. However, alternative balance recovery mechanisms also coexist, namely the regulation of the center of pressure within the base of support, the regulation of the angular momentum, or the use of an alternative contact point, e.g. with the hands (Maki & McIlroy, 1997). The use of these different mechanisms might vary depending on the context such as the intensity of the perturbation or external constraints limiting for example the ability to take a step.

Objectives and working directions

The main objective of this internship is to propose a more complete description of the balance recovery mechanisms following push-perturbations.

The following tasks will be considered:

- The design and pre-test of an alternative experiment to emphasize the strategy of using an alternative contact point; e.g. by providing possible hand contact surfaces and by limiting the stepping possibility.
- The reanalysis of Thomas Chatagnon's experimental dataset to quantify the use of the fixed-support strategies (displacement of the center of pressure within the base of support and regulation of the angular momentum);

The results of this internship will enhance our understanding of balance recovery mechanisms, with important applications in fall prevention, particularly in dense crowds where physical contact occurs under constrained conditions (Chatagnon et al., 2024, Zhao et al., 2024). This work may also have direct application for a new generation of crowd simulation (Jensen et al., 2023, Shang et al., 2024).

The following skills and interests will be valued:

- Background in (bio)mechanics
- Statistical analysis
- Experimental approaches
- Programmation langages: Python, Matlab

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