

# Inclusive navigation assistance in powered wheelchairs for people with neurological pathologies: from virtual to real

## Encadrement :

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## Context

This project is part of the work of the IH2A Chair (Innovations, Disability, Autonomy and Accessibility - INSA Rennes) and aims to propose technological solutions adapted to compensate for sensory-motor and/or cognitive disabilities limiting mobility and autonomy of people. This work is based on cutting-edge research (in robotics and virtual reality) in close connection with clinical research: inclusion of the needs of users and clinicians from the start of the projects until the achievement of the technological solutions developed on the basis of a user-centered approach, via clinical evaluations and technological transfer to satisfy the purpose of such research, namely the provision of relevant solutions to the greatest number of people who need them.

Thus, this project aims to take advantage of the local initiative already in place and to strengthen it around the development of a solution to help **social and inclusive mobility** with an emphasis on the involvement of local authorities.



## Objectives of the thesis work

For people with disabilities who use powered wheelchairs, their ability to **move around safely in all living spaces** is essential for social inclusion. Thus, the development of a **social navigation** assistance is required for a **more inclusive mobility**. This project aims to develop a navigation assistance that takes into account the **social conventions** related to the movements of different users in public space (pedestrians, wheelchair users...). The idea is to provide an electric wheelchair mobility aid that combines both safety and compliance with the specificities of interactions (wheelchair/pedestrian crossing...).

The objective of this thesis is therefore to propose an advanced shared control model for a robust and realistic social navigation of the wheelchair in outdoor environments. Based on previous work done in the Rainbow team, the aim is to develop an assistance function directly adaptable to the user, which could take into account both purely local constraints (avoidance of falls, collisions) and social constraints. It will also be necessary to consider the perception aspect of the system. The proposed algorithms will have to be deployed both on the virtual platform and on the real wheelchair in order to validate them both scientifically and clinically. The implementation of the algorithms in virtual reality allows on the one hand to safely test the control laws in dynamic environments before realizing the real prototypes, and on the other hand to validate the clinical benefit of a learning solution. Ongoing work on the behavior of walkers in the presence of a wheelchair will be exploited as well as work on crowd simulation.

This solution would of course be developed on the basis of a user-centered approach by including users and caregivers (clinicians, occupational therapists, caregivers, etc.) in the loop from the start. It would then be validated on a virtual reality driving simulator, both technologically and clinically through clinical trials.

Finally, this project aims to carry out usage tests and validate the solution in a real environment with users through ecological trials in public spaces in Rennes Métropole.

### **Thesis environment - Partnership**

This project is a follow-up to the work carried out by the Rainbow and Hybrid teams in the joint framework of the Interreg ADAPT project (2017-2022). This work led to the definition of a prototype of a wheelchair capable of performing local and precise navigation tasks, as well as an powered wheelchair driving simulator. Clinical studies, conducted by the rehabilitation center of the Pôle Saint Hélier, have demonstrated the interest of those tools and have specified the scenarios for which the proposal is relevant. At the end of this study, the Pôle Saint Hélier and the Rainbow and Hybrid teams have decided to continue the work, to widen the perspectives in relation with social navigation.

All this work will be the subject of clinical studies carried out both in the laboratory and in an ecological environment, using the structures and means that can be made available by the partners (Immerstar, Pôle Saint Hélier, Musée de Bretagne and Musée des Beaux Arts - Rennes Métropole).

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