UNIVERSITÉ Clermont Auvergne

CLERMONT AUVERGNE INP

ÉCOLE DOCTORALE DES SCIENCES POUR L'INGÉNIEUR

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Title of PhD subject: Design and implementation of control strategies to enable playful interaction scenarios with assistive robots to improve their acceptance by children with disabilities

Summary:

Existing assistive robots are mostly designed for adults and remain expensive, slow, and poorly suited to the developmental and cognitive needs of children. Their adoption is low: young users often prefer to rely on caregivers due to the lack of intuitive and enjoyable interaction. The challenge, therefore, is to integrate these robots into playful, social, and motivating activities to encourage their use and prepare children for future autonomy—particularly in professional settings.

In an ideal scenario, a child with a disability should be able to communicate to the robot, using an appropriate method (voice, touch interface, eye tracking, EMG sensor), that they want to engage in a playful activity, such as drawing an object. The robot will then perform the task, either autonomously—drawing the requested shape on a sheet of paper—or teleoperated with assistance—where the child controls the robot using their usual interface, and the robot guides its trajectory to facilitate the drawing.

The robot must therefore be able to:

- understand the child's intentions via multimodal interfaces
- plan its trajectory to adapt to the child's environment
- perform an autonomous task (e.g., draw a shape) or one with teleoperation assistance

Depending on their profile, the selected candidate may focus on all or some of the following objectives:

1. Define a control strategy based on a "classic" mechanical and automatic approach and a more adaptive approach using AI strategies and multimodal perception (RGBD camera, EMG sensor, eye tracking, hand tracking, etc.) to enable a child with a disability to intuitively control a compensatory robot for play.

2. Model the robotic operations necessary for the targeted play activities in order to select the appropriate sensors, information processing systems, and technical solutions.

3. Develop child-friendly interfaces (visual, vocal, and gestural) compatible with the Orthopus Explorer robot and adaptable to other robots on the market (such as Kinova's Jaco).

4. Improve the robot's control settings to achieve intuitive and therefore safer behavior for the child.

5. Develop a movement planning system that incorporates the user's intentions (via LLMs) and their environment (via CNNs and Transformers), based on reinforcement learning techniques, diffusion models, and imitation learning (GANs, GAILs, IRLs).

6. Validate the chosen solutions through initial testing in a hospital setting (Estaing University Hospital) and potentially in real-world conditions at the patient's home.