Ecole Centrale de Lyon - INSA de Lyon - Université Claude Bernard Lyon 1

Laboratoire Ampère

Unité Mixte de Recherche du CNRS - UMR 5005

Génie Electrique, Electromagnétisme, Automatique, Microbiologie Environnementale et Applications

Haptic Devices for Proprioception Assessment

Introduction:

Proprioception, the ability to sense the position, movement, and orientation of one's body parts, plays a crucial role in motor control and coordination. Impairments in proprioception are common in various neurological conditions such as stroke, Parkinson's disease, and spinal cord injuries, significantly affecting an individual's functional abilities and quality of life. Traditional methods for assessing proprioception often lack precision and sensitivity (Figure 1), requiring the development of innovative technologies to accurately evaluate and rehabilitate proprioceptive deficits. Haptic devices (Figure 2) offer a promising path for enhancing proprioception assessment by providing tactile feedback to users, replicating real-world sensory experiences, and facilitating targeted rehabilitation interventions.

This proposal outlines a comprehensive research agenda focused on the design, development, and evaluation of haptic devices for proprioception assessment in neurological rehabilitation. By combining engineering expertise with insights from rehabilitation science and clinical practice, this research seeks to address the pressing need for accurate and accessible tools to assess and rehabilitate proprioceptive deficits. The proposed study holds significant promise for improving outcomes and enhancing the quality of care for individuals with neurological conditions affecting proprioception.

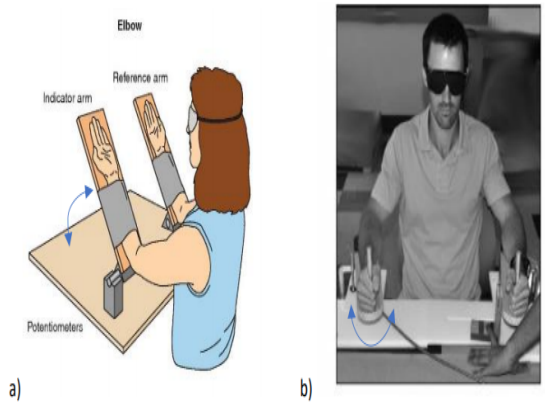

Figure 1: Proprioception tools

Figure 2: Commercial haptic device

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Objectives:

This research aims to design, develop, and evaluate novel tools based on haptic devices specifically tailored for proprioception assessment. The key objectives of the proposed study are:

- To review existing literature on proprioception assessment methods and haptic feedback technologies.
- To design and prototype haptic devices or use commercial haptic device capable of providing varied and controlled tactile stimuli to assess proprioceptive acuity across different joints and movement tasks.
- To validate the effectiveness of the designed/chosen haptic devices in quantifying proprioceptive deficits in individuals with neurological conditions.
- To explore the feasibility of integrating the haptic devices into existing rehabilitation protocols for proprioceptive training and motor rehabilitation.
- To assess the usability, acceptability, and user experience of the developed haptic devices among clinicians and patients.

Methodology:

The proposed research will follow a multidisciplinary approach, combining principles from control engineering, robotics and neuroscience, rehabilitation science, and human-computer interaction. The methodology will encompass the following phases:

- Literature Review: Conduct a comprehensive review of existing studies on proprioception assessment methods, haptic feedback technologies, and rehabilitation approaches for proprioceptive deficits.
- Device Design and Prototyping: Utilize principles of mechanical engineering, robotics, and materials science to design and fabricate haptic devices capable of delivering precise and customizable tactile feedback. Another path could be the use of a commercial haptic device carefully chosen.
- Validation Studies: Perform experimental studies involving healthy participants and individuals with proprioceptive impairments to validate the accuracy, reliability, and sensitivity of the designed haptic devices in assessing proprioceptive function.
- Integration with Rehabilitation: Collaborate with rehabilitation specialists to integrate the haptic devices into existing therapy protocols and evaluate their efficacy in improving proprioception and motor function.
- User Feedback and Iterative Design: Collect feedback from clinicians, therapists, and patients to refine the design, functionality, and usability of the haptic devices through iterative prototyping.

Expected Contributions:

The proposed research is expected to make several contributions to the fields of rehabilitation engineering and neurorehabilitation, including:

- Development of innovative haptic devices for precise and objective assessment of proprioceptive deficits.
- Enhancement of rehabilitation protocols through targeted proprioceptive training using customized haptic feedback.
- Advancement of knowledge on proprioception assessment techniques and their application in clinical practice.
- Potential improvements in patient outcomes and quality of life through personalized and effective proprioceptive rehabilitation interventions.

Keywords:

robotics, haptics, neuroscience

Expected Collaboration:

A part of the work will be developed with Lyon Neuroscience Research Centre with the Impact team of Alessandro Farne and Salam Bahmad

https://www.crnl.fr/en/equipe/impact

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