HearWalk: Co-designing and Building a Sound Feedback System for Hemiparetic Gait Training

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DEMO VIDEOS

Background

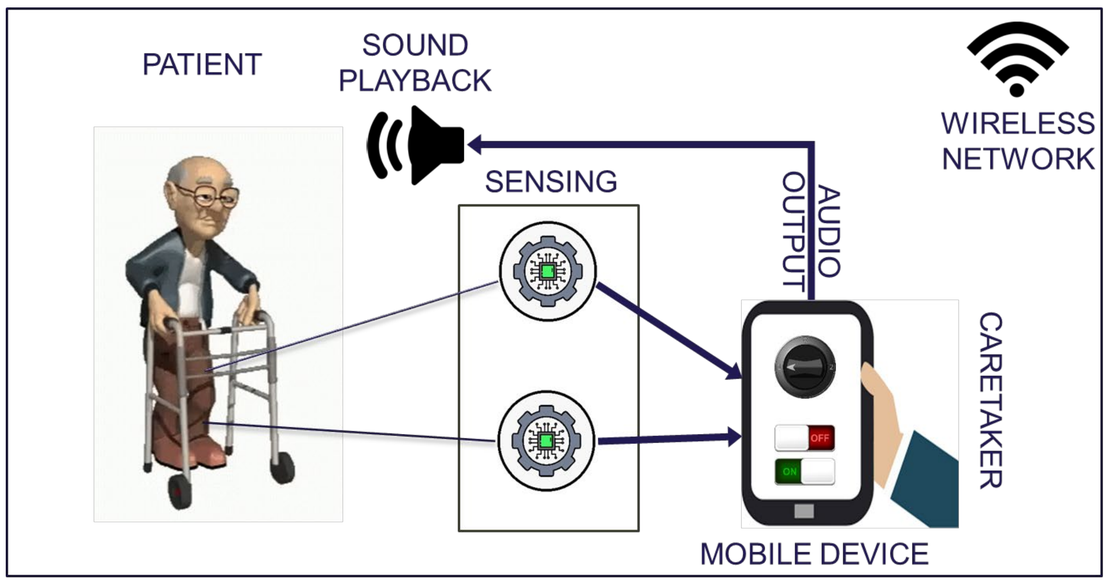
Sound feedback technology has been increasingly explored as a tool to enhance motor learning during gait rehabilitation.

Hemiparetic patients typically exhibit **intra-group variability**, so it is very important for assistive technological systems to be **patient-tailored** and cater to the diversity of individual needs.

It is recommended that **patients and professionals are systematically and meaningfully involved** in technology development processes so as to **enhance the usability and user acceptance** of the technology.

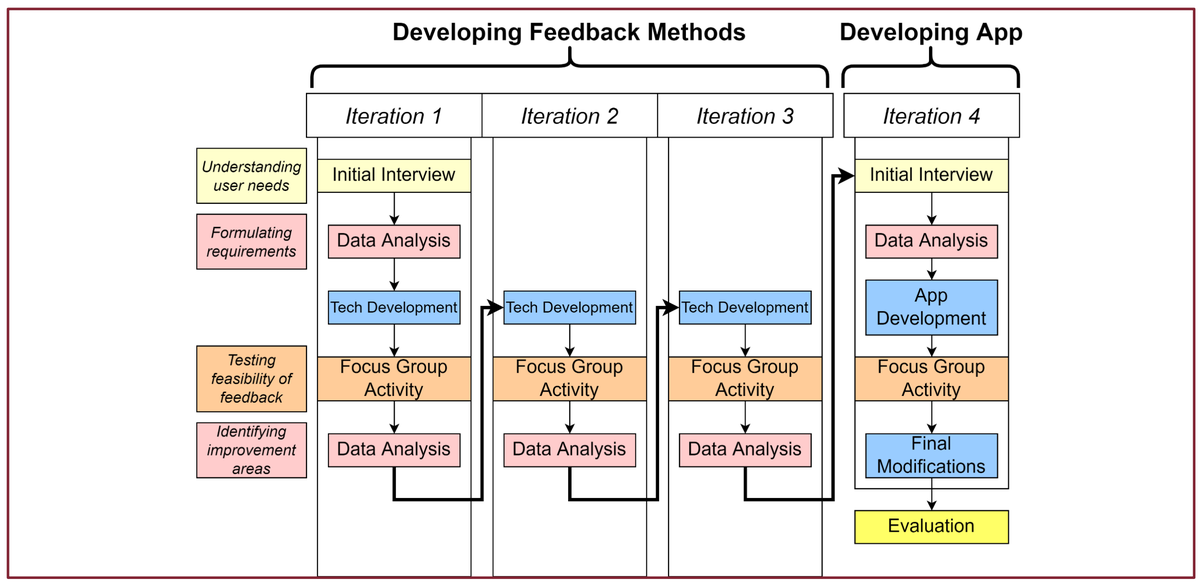
Objective

To collaborate with physiotherapists on developing and testing the feasibility of a low-cost sound feedback system with multiple feedback designs compatible with conventional gait training protocols.



Use-case Scenarios

Exercise Name	Focus	Overview	Patient Goal
Overground Walk – **Wading Feedback**	Symmetry Swing Phase	Sounds like walking through water	Identical sound on left / right
Single-sided stand – **Music Feedback**	Knee Extension Control	Music interrupted by noise if knee flexes or hyperextends	Maintain full knee extension without hyperextending
Overground Walk – **Step Length Feedback**	Paretic Step Length	Reward 'PLING' sound if desired step length achieved	Achieve reward sound during every paretic limb step



Methods

Our research employed a **user-centered approach**, encapsulated in four iterative cycles of design, development, and evaluation.

Key to this process was the **active involvement of a focus group** of therapists, who collaboratively delineated clinical use-case scenarios, defined general patients' needs and abilities, and proposed sound feedback ideas.

Following each development phase, the resulting strategies underwent rigorous scrutiny by the **focus group in an interview and testing setting**. To assess practicality and usability of the sound feedback, we executed **feasibility studies involving patient-therapist pairs**.

Subsequent iterations were shaped by their expert insights, leading to the **final prototype system** comprising a portable wireless system made up of inexpensive motion sensors, a mobile app, and a sound playback system.

Takeaways and Perspectives

We defined, designed, and developed three **concrete use case scenarios (see demo videos)**, which were found to be easily integrable with conventional rehabilitation protocols and of potential therapeutic benefit to several patient types.

Patients exhibited a **large amount of variability in terms of physical and cognitive abilities, general auditory comprehension, and preferences**, which supports the notion that the feedback may not be universally applicable, and that the system needs to be adjustable to the individual patient.

Further research and development will be necessary to develop **use-cases for specific patient subgroups and movement impairments**, which is the subject of future work.

Overall, despite the expensive and time-consuming nature of user-centered design methodologies, this project adds to a growing body of evidence that **clinical stakeholder perspectives are crucial to the effective development and implementation** of rehabilitation technology at large.

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