## Walking aid with haptic feedback for combined use with a smart foot orthosis

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**Purpose** Elderly people often face the risk of falls, which increases the need for walking aids to ensure mobility and safety. The occurrence of further injuries requires the use of additional orthopedic aids (e.g., foot orthoses). Wearing such an orthopedic aid also impairs the natural gait pattern, which leads to increased instability in older patients. This highlights the need for innovative solutions for assistive smart walking aids. Doan et al., for example, presented a smart walking aid for fall detection that can detect falls based on machine learning with an accuracy of 99.62% (Doan et al., 2024). This development can lead to improvements in home care and remote health monitoring technologies. However, a solution that allows the combined use of an intelligent walking aid with a smart foot orthosis to provide patients with active feedback does not exist. Based on the identified research gap, we propose the technical development of an augmented walking aid with haptic feedback that enables direct communication of sensor data with a smart foot orthosis. Providing additional feedback in case of problems with the foot orthosis is particularly important for patients with neuropathy in the feet (such as diabetic foot syndrome), for which neural feedback is not possible. Our approach enables direct haptic feedback through vibrations on the handle of the walking aid when acute problems are detected by the smart foot orthosis. The system achieves this by continuously monitoring relevant gait parameters and pressure distributions in the foot orthosis. This should support the proactive adaptation of gait problems and increase safety when using assistive technologies for older people. **Method** The concept development is based on a comprehensive literature analysis of existing walking aids, as well as the identification of patient needs for the use of augmented feedback and wearable technologies. Based on these findings, we have developed an initial concept for a feedback-enabled walking aid designed for combined use with a smart foot orthosis, which provides real-time feedback on the patient's gait behavior. Figure 1 shows the proposed conceptual design of the intelligent walking aid with an integrated vibration motor on the handle and an inertial measurement unit to determine the spatial parameters. Wireless communication of recorded data occurs via Bluetooth. **Results and Discussion** We propose to investigate the system in an experimental within-subject study to evaluate the effectiveness of gait improvement, as well as usability and social acceptance, with a sample size of 20 participants. In this context, we intend to use the think-aloud protocol to gain deeper insights into the participants' thought processes during interaction with the system. By combining the proposed concept with a smart foot wearable device that provides specific data on foot positioning and movement, we expect a more reliable gait analysis and better tailored corrective suggestions. Additionally, the application of machine learning allows the identification of gait patterns and the initiation of preventive measures against potential fall risks. In future applications, the system can be modularly expanded to include additional walking aids, such as walking sticks, crutches, or walkers.

**References**

Doan, T. N., Schroter, E., & Phan, T. B. (2024). Fall detection using intelligent walking-aids and machine learning methods. In N. Thai-Nghe, T. N. Do, & P. Haddawy (Eds.), *Intelligent systems and data science*, ISDS 2023 (Communications in Computer and Information Science, Vol. 1949, pp. 1-10). Springer. https://doi.org/10.1007/978-981-99-7649-2_8

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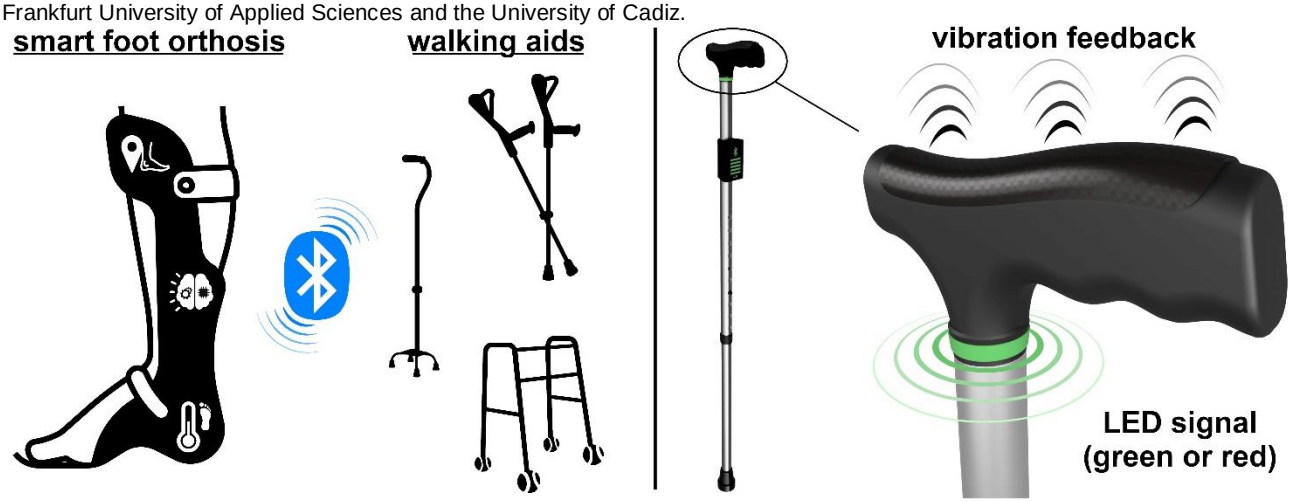


*Figure 1. Schematic representation of the intelligent foot orthosis in combined use with the haptic walking aid*