Usability Study of an Intelligent Robotic Walker for Lower-Limb Motor Training

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Abstract. The RoboTrainer is an intelligent robotic walker that provides force-controlled lower-limb motor training. This short paper presents the results of a usability study using the standardized System Usability Scale (SUS) question-naire. The average SUS score from 28 healthy participants was 76.6 ± 12.5. We compared this score with a meta-analysis of 67 robotic rehabilitation devices, demonstrating that the RoboTrainer's usability exceeds the field's average. These findings suggest the technology has strong potential for successful adoption.

Keywords: System Usability Scale, Human-Robot Interaction, Robotic Walker

1 Introduction

Lower-limb motor performance declines with increasing age due to muscle loss (35% be-tween the ages of 40 and 80 [1]). This can lead to an increased risk of injury from falls [2]. Additionally, over 20% of nursing home residents have mild cognitive impairment [3], and 60% of these individuals will develop dementia during their lifetime [4]. Studies show that interventions involving motor and cognitive stimulation can maintain or even improve these functions [5][6]. In this context, individualized and adaptive training programs are essential, as they can provide appropriate challenges to ensure effective training. Given the aging society [7] and the shortage of skilled healthcare workers [8], automating the training process with easy-to-use devices is essential to address these issues.

The RoboTrainer, an intelligent robotic walker currently in development, addresses this problem by providing force-controlled lower-limb motor training with additional cognitive challenges [9]. The RoboTrainer uses machine learning to automatically assess performance and adapt task difficulty to provide individualized training [10].

High usability is important if a device is to be adopted in care homes and used for daily training. It must be intuitive to use for both patients and clinical staff. Poor usability can lead to user frustration, high error rates, patient rejection, and ultimately, abandonment of the technology, regardless of its therapeutic potential.

The contributions of this paper are the results of a usability study:
1. Presentation of the System Usability Scale (SUS) evaluation of the RoboTrainer.
2. Comparison of the results with other robotic rehabilitation devices.

2 Method

The usability study was part of a larger technical feasibility study aimed at collecting data and testing the automatic assessment algorithms. A total of 28 participants (9 female, 19 male; mean age 34.7 ± 12.8 years) were recruited for this study. The inclusion criterion
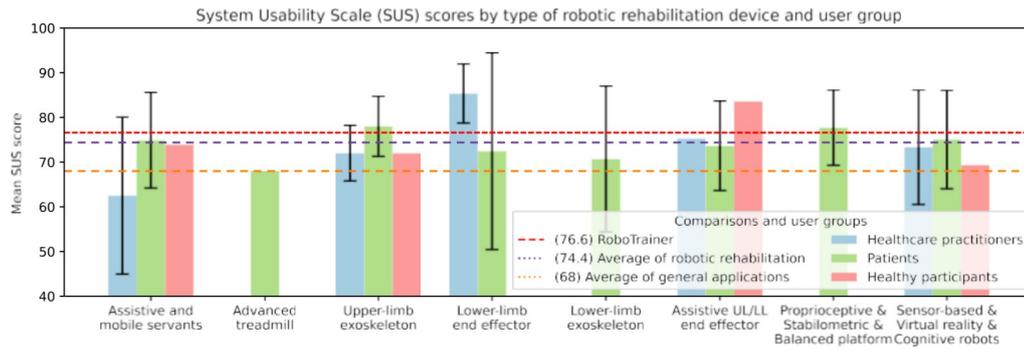
System Usability Scale (SUS) scores by type of robotic rehabilitation device and user group

Fig. 1. The SUS score of RoboTrainer compared with other robotic rehabilitation devices [14].

was the absence of cognitive or mobility impairments. Each participant completed a series of 20 different tasks with RoboTrainer for one hour. After the session, usability was quantified using the standardized 10-item SUS questionnaire [11]. The SUS is a validated questionnaire that provides a global score of perceived usability from 0 to 100.

3   Results

The reported SUS score for RoboTrainer is 76.6 ± 12.5, which is considered "good" usability and belongs to the top 22nd percentile [12]. This indicates a high level of user acceptance, ease of use, and system consistency. The average score for general industry applications is 68 ± 12.5 [13].

To contextualize these findings, we compared our results to a recent meta-analysis by Nicora et al. (2025), which analyzed 67 studies on robotic rehabilitation devices [14]. The average SUS score across all devices and user groups was 74.4 ± 11.3 as shown in Figure 1. The RoboTrainer belongs to the device category of lower-limb end effectors and was evaluated with healthy participants. This device category includes a total of six studies with a mean score of 85.4 ± 6.6. The most comparable device is the FriWalk robotic walker, which recieved a score of 52.8 by 42 elderly patients and 68.0 by one clinical professional [15]. Another is the SWalker, which achieved 91.3 by two physiotherapists [16]. Furthermore, our healthy user score of 76.6 can be compared to the meta-analysis average for all studies involving healthy participants (n = 4), which was 74.0.

The primary limitation of this technical pilot study is its use of a healthy user group that does not represent the final target population of older adults with potential impair-ments. This limitation is also reflected in the qualitative feedback, as some participants found the question about "frequent use" (item 1) difficult to answer. However, the over-whelmingly positive score confirms the system's core intuitiveness and ease of interaction.

4   Conclusion

This paper presents a usability evaluation of the RoboTrainer as a first step towards its clinical application. The resulting SUS score of 76.6 ± 12.5 from healthy partici-pants exceeds the average usability scores for both general industry applications and other rehabilitation devices. Future work will focus on validating these promising results with the target population of older adults and on further developing the RoboTrainer's individualization algorithms.

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