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Application of AI-based assistive robotics to reinforce learning of daily living actions: initial technical validation with users

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Abstract

This paper presents an assistive robotic application that enables people with disabilities to improve their participation in daily living activities and mobility. Technically, we describe an assistive robot where we implement an online action detection model, which is integrated in an application software that is able to track the progress of users in terms of learning and reinforcement of four dissimilar everyday activities. In this work, we report a first technical validation based on four-week trials with four subjects. There were a variety of neurodevelopmental disorders present in the subjects who participated in the sessions. By considering this aspect, we are able to predict how the system will behave with real end users and the main results of this technical validation are presented. Overall, we can conclude that the artificial intelligence modules for action recognition have performed well, and that the designed user application allows to track the learning and reinforcement of daily life activities performed by the users.

1 Introduction

This work presents the first study of a technical validation for a low-cost assistive robotic platform specifically designed to support the learning of day-to-day activities for people with neurodevelopmental disorders (NDDs). This platform is known as LOLA [1], and it is developed based on an artificial intelligence application designed to assist individuals with disabilities in

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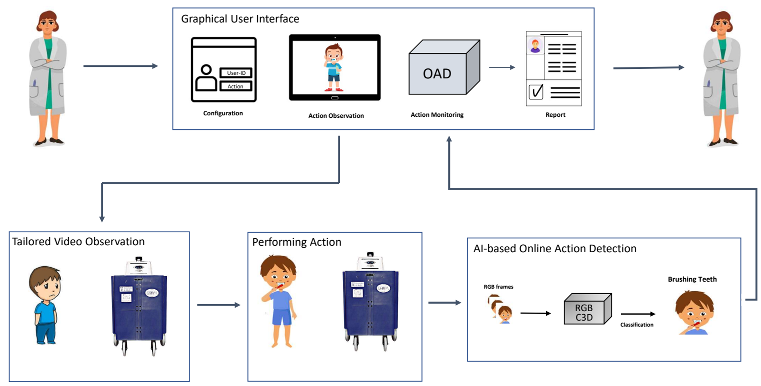

Figure 1: This figure illustrates the workflow of action monitoring with LOLA and users with NDDs. The health professional selects an appropriate action, and the patient watches a video of the action. AI-based monitoring action should be activated once the patient is ready. After each session, the health professional will receive a report detailing the patient's progress.

learning and reinforcing daily living activities. To facilitate user interaction with the robot, the proposed robot is also equipped with a user-friendly graphical interface to access the action monitoring system. The system incorporates an online monitoring model that facilitates the detection of patient actions. To conduct this evaluation trial, we utilized the online action detection module proposed in [2], and selected the four most common daily living activities from the included categories such as *Blow Dry Hair, Brushing Teeth, Writing On Board* and *Mopping Floor*. Lastly, the platform generates a report for each session based on the results of the action monitoring system for each patient, so that the responsible healthcare professional can gauge the progress of each patient during therapy sessions. Figure 1 provides an overview of the entire process.

2 Results and Discussions

A four-week trial period was conducted in this technical validation in which four patients with different levels of NDDs participated. In accordance with the protocol detailed in [3], they were selected and ranged in age from 7 to 23 years of age.

In the first case, a 7 year old female was diagnosed with idiopathic ataxia. She was unable to walk without a walker and had difficulty manipulating objects. In the second case, the patient was a 14-year-old female who has been diagnosed with Cerebral Palsy - Spastic Diparesis. She was able to walk under most conditions and manipulate most objects, but with some limitations. As the third patient, she was a 15-year-old female with Cerebral Palsy – Spastic Triparesis characterized by a predominance of the right side. Despite her limited mobility, she was able to walk in most situations and manipulate objects with difficulty. The last participant in this technical validation, a 23-year-old female, was diagnosed with metabolic syndrome as a result of GLUT 1 deficiency. She was therefore capable of walking in most conditions and manipulating most objects, although the quality and speed of her movements were affected.

Figure 2 shows the accuracy of the system for monitoring actions, each of which was repeated twice. In the first two sessions, the first patient assisted with her walker, and the system failed to

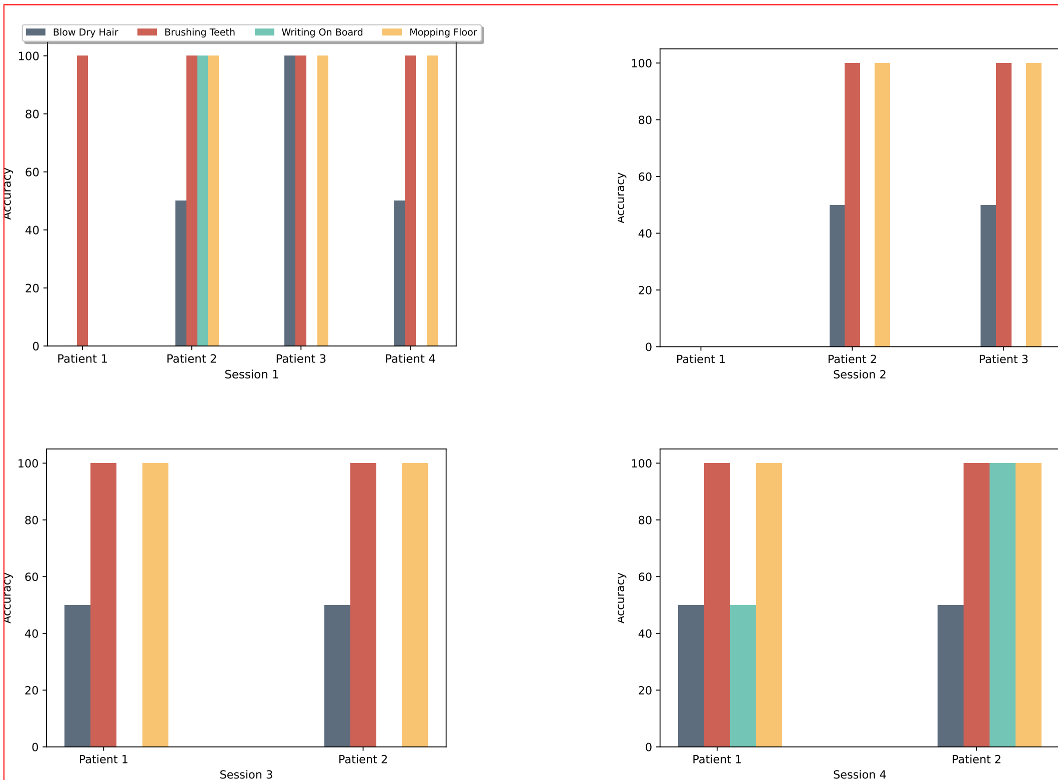

Figure 2: Detailed results of the entire technical validation process of the platform can be found in this figure. The average accuracy of the AI model detection during each session is reported.

recognize her actions. During the remaining sessions, she performed requested actions without her walker with the assistance of her professional responsible. Thus, her performance was largely recognizable by LOLA. The second patient was able to perform all actions independently; however, blow drying hair and writing on a board were the most challenging tasks for her.

As shown in Figure 2 the third and fourth patient did not attend all of the sessions assigned to them for personal reasons. The third patient had difficulty manipulating objects and wrote on board in a way that was unrecognizable for LOLA. For the fourth patient, she only attended the first session and did not show any interest in following up. She had short hair, so LOLA had difficulties detecting the blow drying hair action.

In conclusion, the patients enjoyed interacting with our robot. LOLA was successful in detecting most of the actions accurately. However, some actions require refinement in order to ensure that the system is designed for monitoring people with disabilities and impairments. During its first technical validation with real users, LOLA was generally accepted by healthcare professionals and patients and demonstrated promising results.

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