A Novel Patient-Centered Robotic Rehabilitation Approach for Retraining Reaching and Grasping Functions for Individuals with Stroke

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Introduction

- More than 50% of people with stroke live with upper extremity impairments that hinder daily activities[1].
- Robot-assisted rehabilitation offers consistent, intensive, and task-specific training that promotes motor recovery[2].
- Most systems train movements that yields motor outcomes similar to most other interventions[2,3], but do not simulate functional activities.

Research Question

- How can we leverage the advantages of robotic systems and overcome these limitations?

Objectives

- To develop a robotic rehabilitation system that integrates functional tasks with real objects.
- To dynamically assess upper extremity capabilities and adaptively present targets to users in real time.
- To evaluate the efficacy with persons with and without stroke.

Methods

1. Set up the robotic system with modified 3D-printed objects for functional tasks and constructed a shelf for consistent object positioning and storage.
2. Developed and evaluated algorithms to assess user's reach and adaptively present the objects as targets.
3. Evaluated system performance with participants with and without stroke.

Experimental Setup

Procedure:

1. Capture extent of reach (by drawing a spiral shape)
2. Train reaching and grasping of targets placed within and beyond each user's reach.
3. Data collection is ongoing for our study, the analysis here includes one individual without and one with stroke.

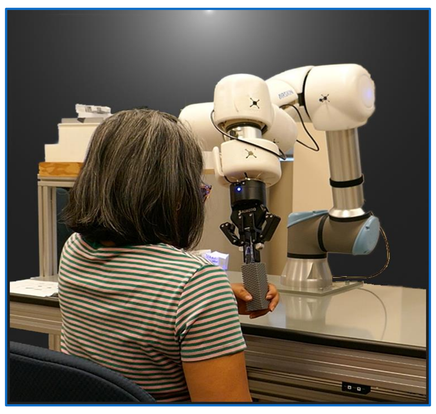


Figure 1: Participant exploring her extent of reach

Results

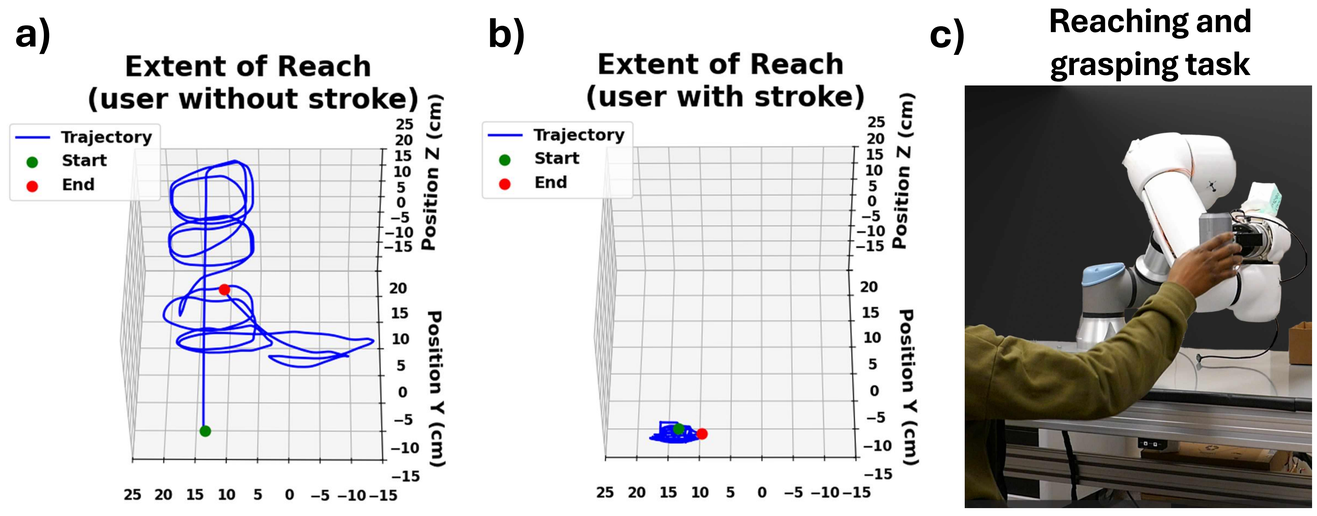


Figure 2: Extent of reach and grasp for individual a) without b) with a stroke and c) a person grasping a pop can presented by the robot

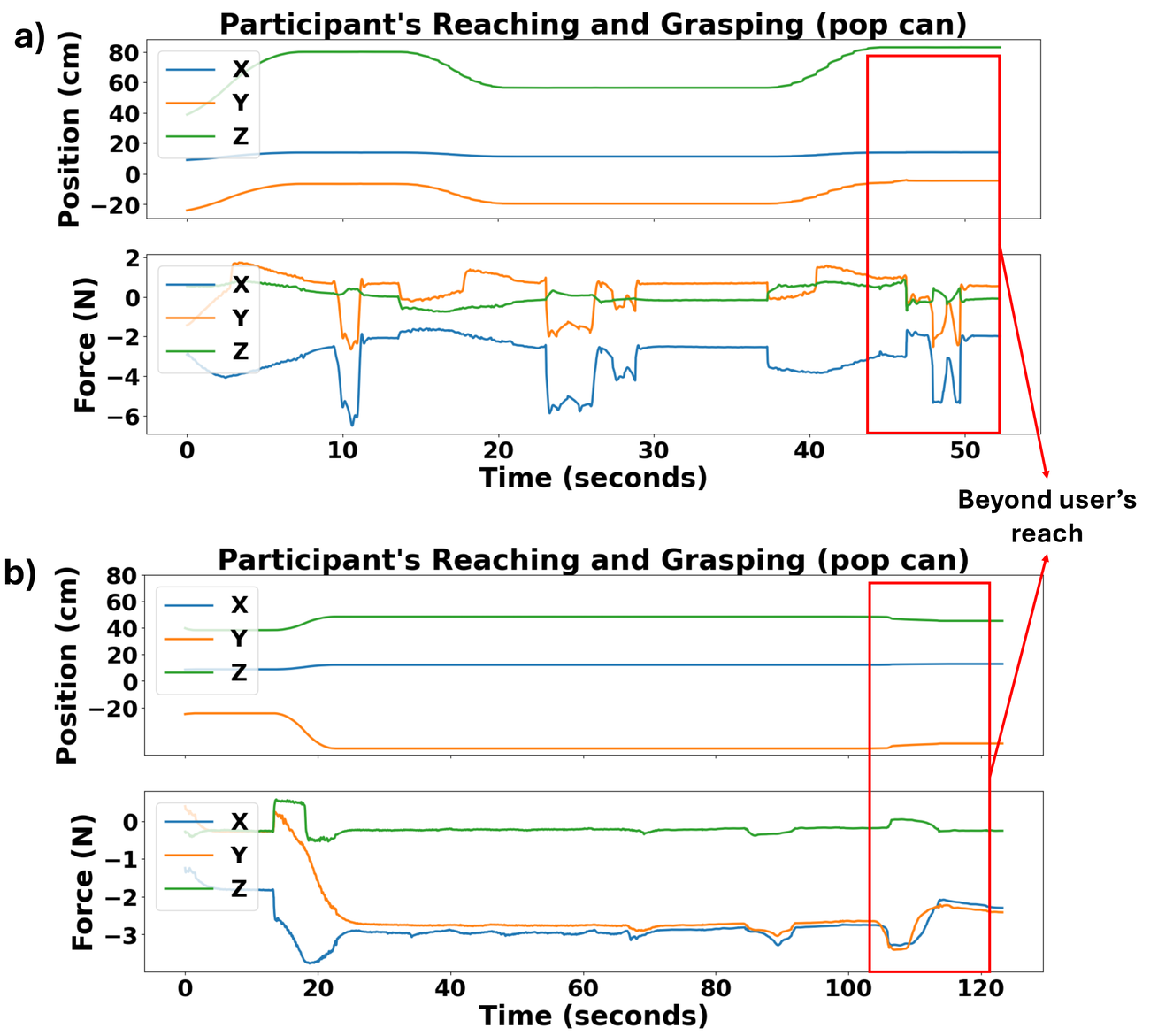


Figure 3: Reaching and grasping task for individual with a) without and b) with a stroke

Discussion

1. We developed a new robotic rehabilitation system that integrates 3D-printed objects to facilitate reaching and grasping tasks.
2. The system assesses reach extent, adaptively presenting targets, and detects object grasp in 3D space.
3. Preliminary evaluation with a person with stroke showed improvements in reach times, suggesting potential for tailored intervention.
4. Can integrate with other interventions such as functional electrical stimulation to improve outcome.

References

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UHN Toronto Rehabilitation Institute — The KITE Research Institute

Institute of Biomedical Engineering, University of Toronto

REL Rehabilitation Engineering Laboratory

TACOS Lab — Therapeutic Applications of Complex Systems Laboratory