The use of technology to provide physical interaction experiences for cognitively able young people who have complex physical disabilities

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1. Overview

This study aims to develop a tool incorporating an eye gaze controlled robotic arm that provides haptic feedback, to enable young people who have severe physical disabilities and good cognition to experience simulated physical manipulation of objects, and simple play.

2. Background

Young people who have complex or severe physical disabilities and good cognition (hereafter referred to as the 'target group' or 'TG') often have limited opportunities to interact with and learn about the physical world. This can be compounded by communication difficulties that restrict their expressive language which, in turn, limits their ability to ask questions about the physical world and articulate their thoughts relating to it [3]. The TG's ability to participate in play activities is also severely restricted, depriving them of an important developmental process [1].

These factors can limit an individual's ability and desire to participate in physical activities which may lead to passivity and a reduced inclination to initiate [2].

The aim of this study is to create a tool that will utilise eye gaze, robotics and haptic feedback (artificial sensation) technologies. Using just their eyes, the TG will be able to manipulate a robotic arm in three dimensions, and instruct the arm's gripper to grasp real-world objects. When an object is gripped, the TG will receive a haptic sensation in their hands, providing a simulated experience of what it is like to pick up and hold an object, something they are not able do themselves.

3. Methods

A 'Mixed Methods' approach will be used in this study.

This research is taking place in a school for children and young people who have special educational needs. The author has worked for ten years as an Assistive Technologist with all members of the TG at the school.

The study will involve the participation of both pupils and staff at the school.

The recruited pupils (or TG) will consist of those who: have severe physical disabilities with little or no voluntary motor control, and have 'good' cognition, having attained 'P Scale' level 6 or above in Mathematics, English and Science.

Early prototypes have been developed, including a range of haptic prototypes and a complete prototype, see Figure 1.

The haptic prototypes have been evaluated by school staff participants from the following professions: Occupational Therapy, Speech and Language Therapy, and Education. Once completed, the proposed tool will also be evaluated by staff participants, after which the TG's participation will commence. This part of the study will follow a pre-test/intervention/post-test design.

The pre-test will consist of a battery of assessments to establish a baseline. These assessments will examine the TG's ability to sense touch in their hands, and also their understanding of physical and spatial concepts.

The intervention stage will involve appropriate training, use of the tool and various trials with the TG.

The post-test will repeat the same battery of assessments used in the pre-test. Pre and post-test results will be compared and analysed.

3.1 Ethical statement

Appropriate ethical approval is in place.

4. Results

The first stage of this research is nearing completion. Initial results and feedback generated from the haptic prototype trials with staff participants, have helped to identify the most suitable devices and will be

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used to improve the design of these prototypes. These findings are discussed in section 5.

5. Discussion

An analysis of the results generated during the staff participant haptic prototype evaluation are summarised here:

- It is not feasible to design a single haptic solution which will meet the needs of all members of the TG. The characteristics of each individual will determine the suitability of a particular design;

- A range of 'perceived' requirements have been identified including: quick attachment / detachment times; adjustable sensation level; a self-contained design – few, or ideally, no external wires; comfortable for the wearer; use only hygienic and non-allergenic materials.

6. Conclusion

This research and the development of the proposed tool are works in progress.

Haptic prototypes have been trialled with staff participants at the school. Their feedback has helped to focus and improve the design of these prototypes.

The next stages of this research will bring together the various elements, including the haptic prototypes, robotics and eye gaze interface into a single solution. These will be evaluated by school staff and then used by the TG using a pre-test/intervention/post-test design.

7. References

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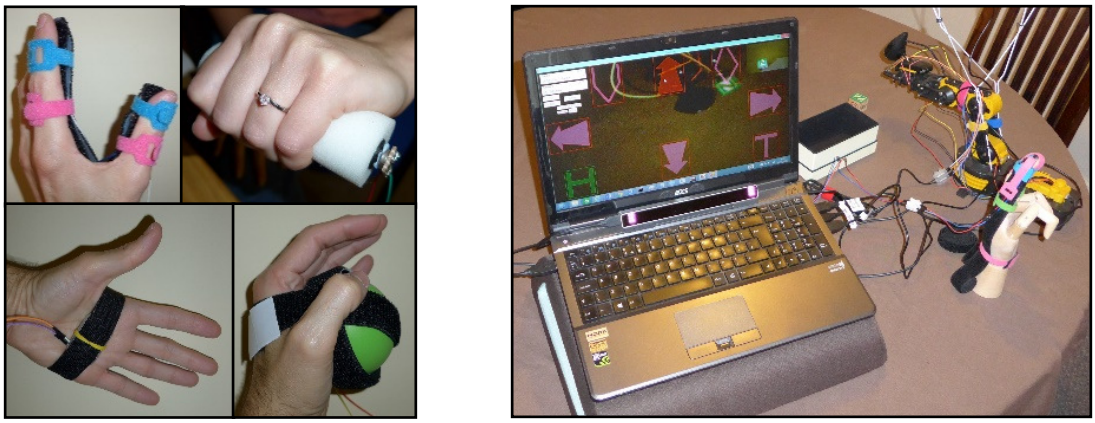

Figure 1: Haptic prototypes and the complete prototype

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