Augmenting functional vision using automated tactile guidance

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Introduction

Humans possess five primary senses, but the brain is capable of processing additional information (**sensory augmentation**). Previous work with the feelSpace tactile belt (naviBelt) assisted visually impaired individuals with spatial navigation.

In the current project, **we aim to assist the visually impaired population in grasping movements with a tactile bracelet** inspired by the naviBelt design.

Fig 1. feelSpace naviBelt (left) and tactile bracelet based on its design (right).

Bracelet proof of concept

Experiment: grasping of the artificial fruits, 8 blocks x 9 trials x 2 conditions (tactile vs. auditory), 30 participants.

Results: **tactile bracelet is a viable alternative to auditory commands** (only 460ms loss in response time, Fig 4) **with noticeable learning effect** (Fig 5).

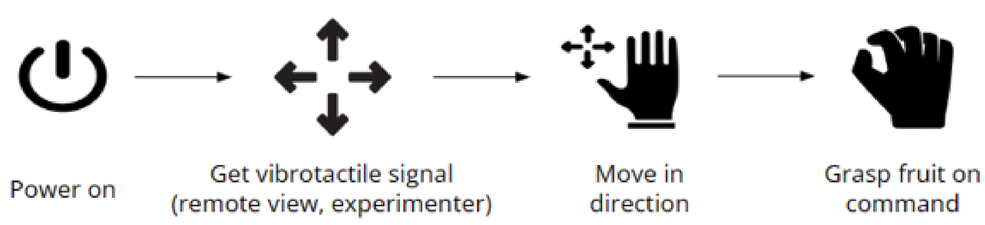

Fig 2. Schematic representation of the experimental trial design.

Fig 3. Example of experimental trial (tactile condition) - participant reaching towards object of interest.

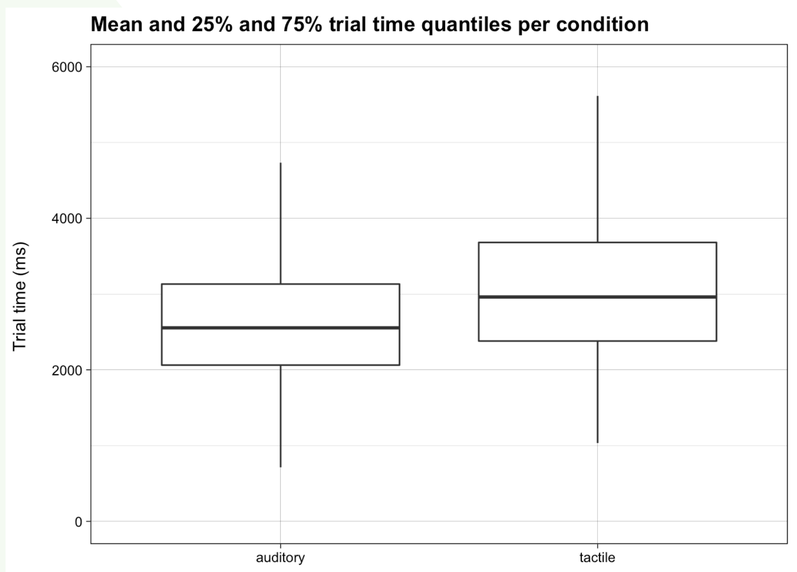

Fig 4. Comparison between mean trial times in auditory and tactile conditions. No significant difference was found.

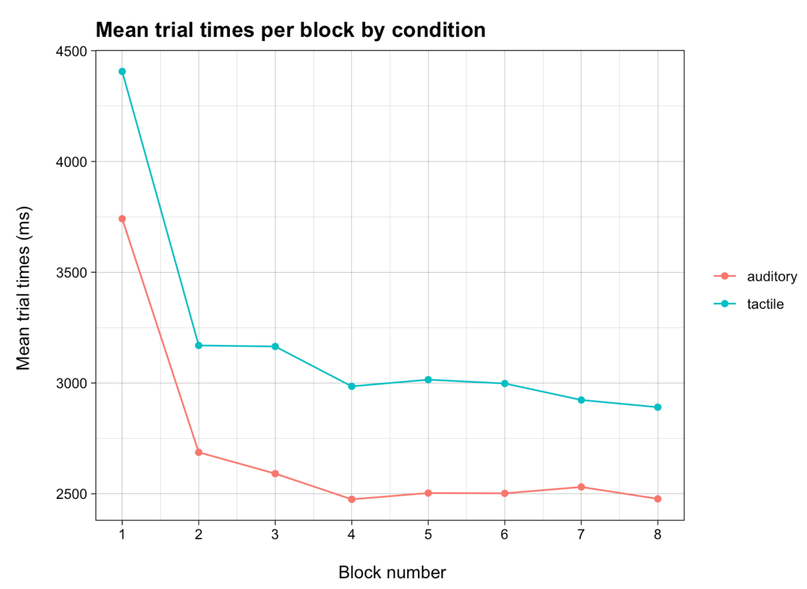

Fig 5. Mean trial times in auditory and tactile conditions across blocks. Strong learning effect visible.

Automation of the solution

Current goal: **replacing the experimenter with a system based on object detectors predictions regarding target objects and hand positions with automated hand navigation logic.**

- Object detection: two YOLOv5 networks (both pre-trained on COCO, with one retrained on a subset of target objects from COCO and the other one retrained on EgoHands dataset) working in parallel.
- Hand navigation logic: based on simple heuristics.

Potential next steps:

- Addition of the object tracking component (DeepSORT).
- Replacing a hand navigation script with transformer ANN trained on real-life grasping movement data.

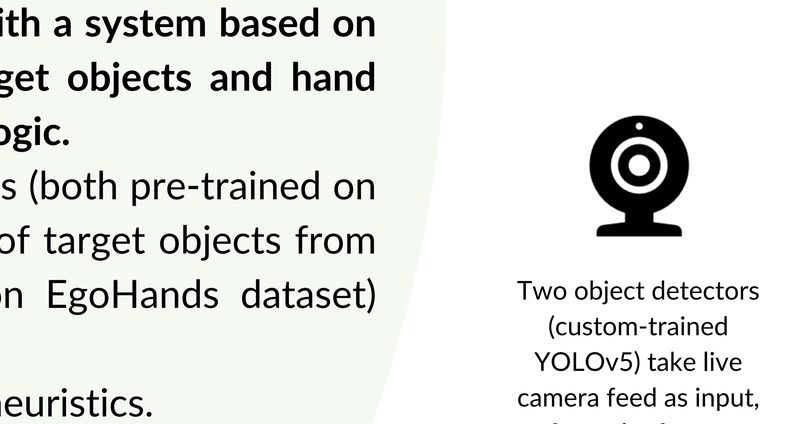

Fig 6. Schematic representation of the experimental design of study aimed at validating an automated solution.

Fig 7. Example of image from the EgoHands dataset.

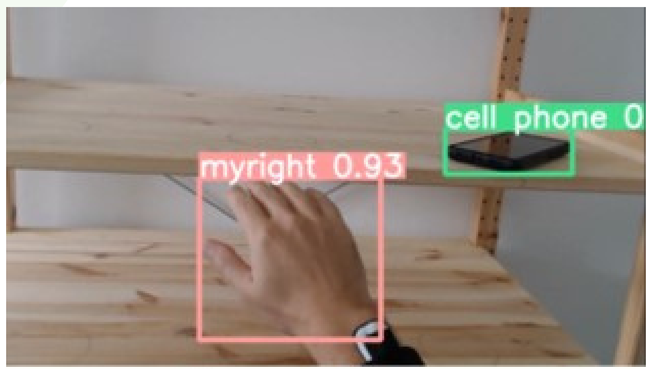

Fig 8. Example of the combined detection.

Scan to learn more about OptiVisT and feelSpace!