Universität Hamburg
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FACHBEREICH INFORMATIK
HUMAN-COMPUTER INTERACTION

STIC
SENSORY AND TACTILE IMPROVED CANE

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ABSTRACT

Navigation and obstacle avoidance, especially regarding **head-level objects**, are of major concern to **visually impaired people**.

We designed an **augmented white cane** using **distance sensors** and **vibrotactile feedback**. Based on a psychometric study, object shiftings by more than 13.58cm yield a 90% detection accuracy.

Additionally, we present **Afterimages**, a novel approach to retain obstacle information.

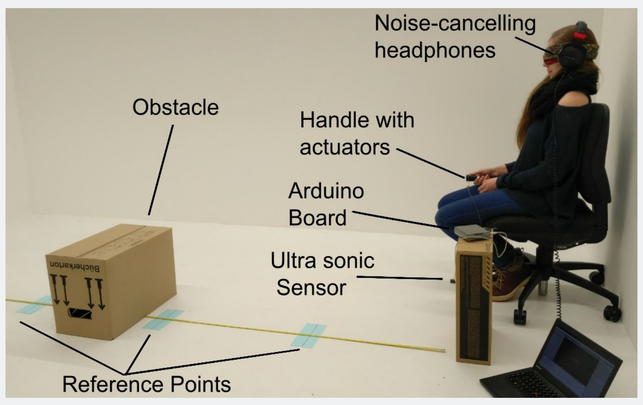
PSYCHOMETRIC STUDY

Goal:

Determine the minimally needed shift distance of an object to have a 90% success rate in participants deciding whether the object was shifted towards or away from the sensor.

Participants:

6 participants (2♀, 4♂) aged from 23 to 36, bl

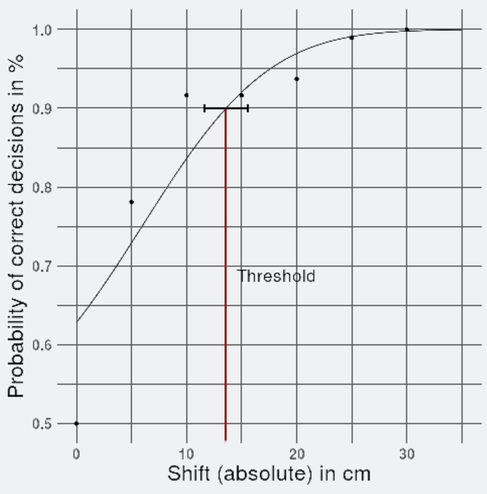


Study Design:

- A box was placed on different reference points and shifted towards or away from the participant
- The participant should decide in which direction the box was shifted based on vibrotactile feedback
- 96 shifts per participant

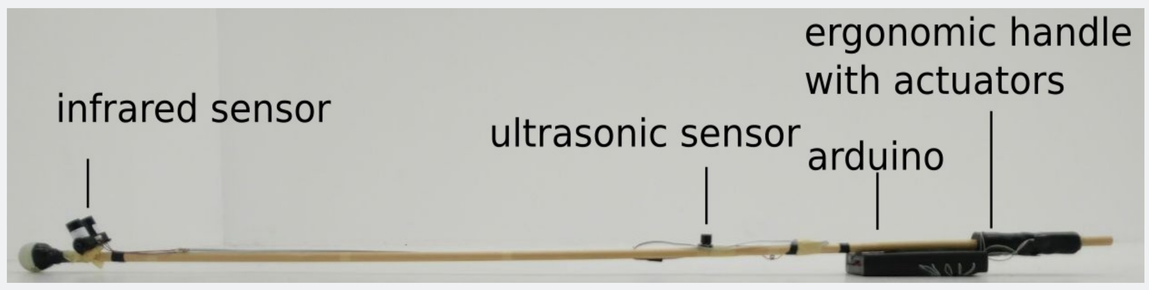
Results:

- **No significant** difference between **shifting directions**
- Paired T-Test: t(5) = -1.22, p > 0.05
- **Strong correlation** between **absolute shift distance and correctness**
  Pearson correlation: r(4) = .091, p < 0.05
- **No significant** difference between **reference points**
  Non-parametric Friedman test: (3) = 5.95, p > 0.1



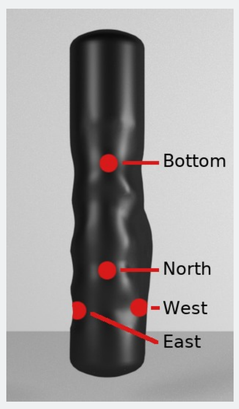
A minimum shift distance of 13.58cm is needed to determine the shifting direction of an object with an accuracy of at least 90% in the participants.

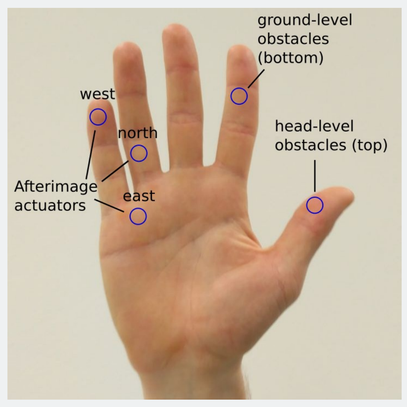
STIC



STIC mimics a typical **white cane** and is extended by an **Arduino** based system. It contains an **infrared sensor** to detect obstacles at **ground-level** and an **ultrasonic sensor** for **head-level** obstacles.

Feedback is provided by 5 **piezo actuators** placed on the handle. Their activation frequency encodes the distance between STIC and detected objects.

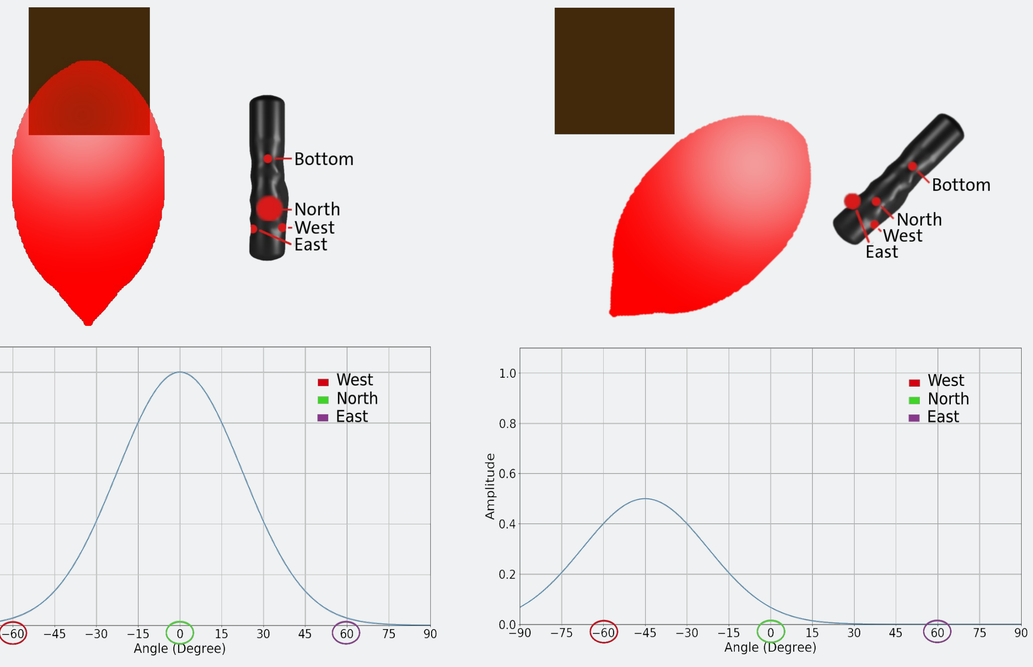




AFTERIMAGE TECHNOLOGY

STIC “remembers” obstacle location for a specific duration. This way, when the user rotates or swipes STIC away from an object, haptic feedback still indicates the **actual position of the object relative to the user**.

Over the Afterimage lifetime, the vibration amplitude decreases until it fades away.



Example: After an obstacle is detected (left), its Afterimage remains while the cane is rotated around 45° (right). In the meantime, the haptic feedback decreases and moves from the north to the east actuator.

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