Karlsruher Institut für Technologie

Cognitive Evaluation of Haptic and Audio Feedback in Short Range Navigation Tasks

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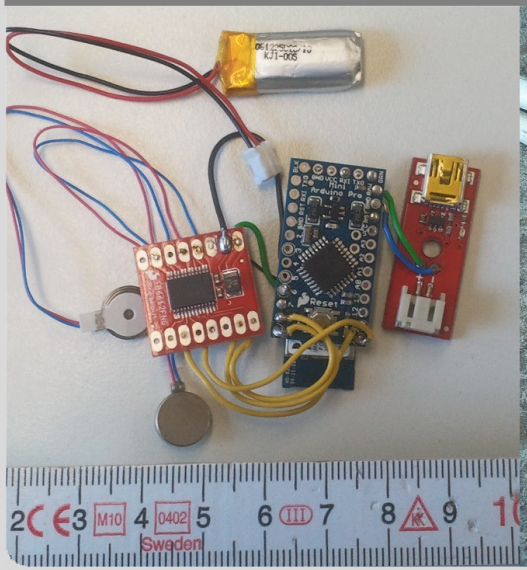
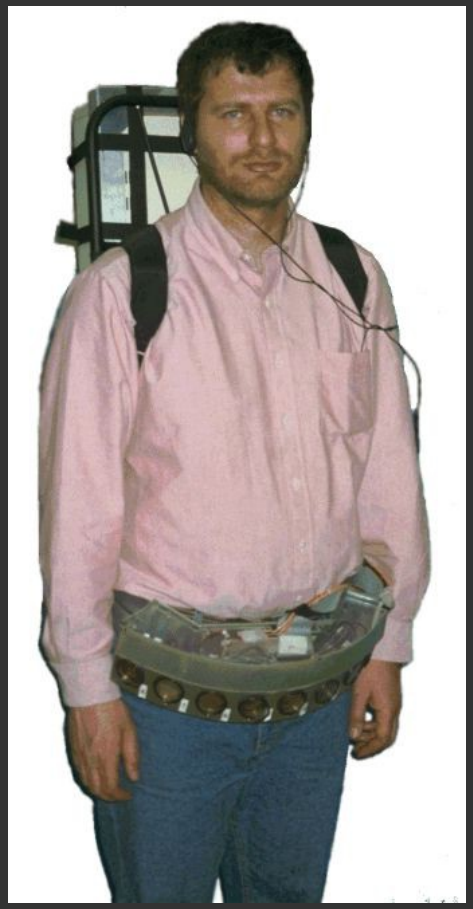
STUDY CENTER FOR VISUALLY IMPAIRED STUDENTS



Motivation

- Several projects work on short range guidance; digitally enhanced white canes and other approaches
- Focus is usually on the very challenging perception task
- However, there exists a lack of consensus on how to convey navigation information to a blind user

Audio Based Systems

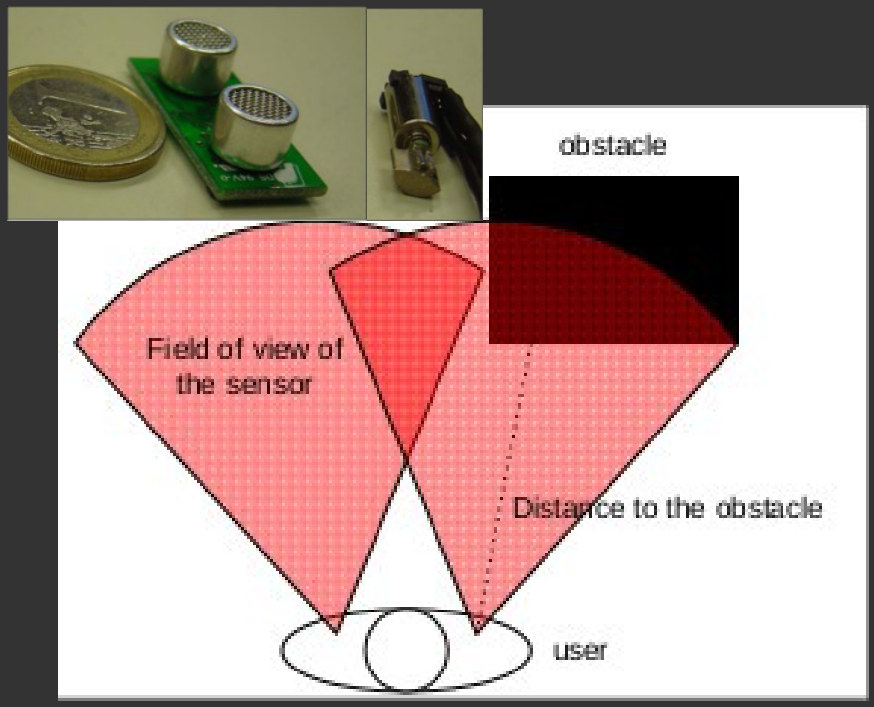


Shoval et al., “Navbelt and the guide-cane”, IEEE Robotics Automation Magazine, 2003

Schauerte et al., “An assistive Vision System for the Blind that Helps Find Lost Things”, ICCHP 2012

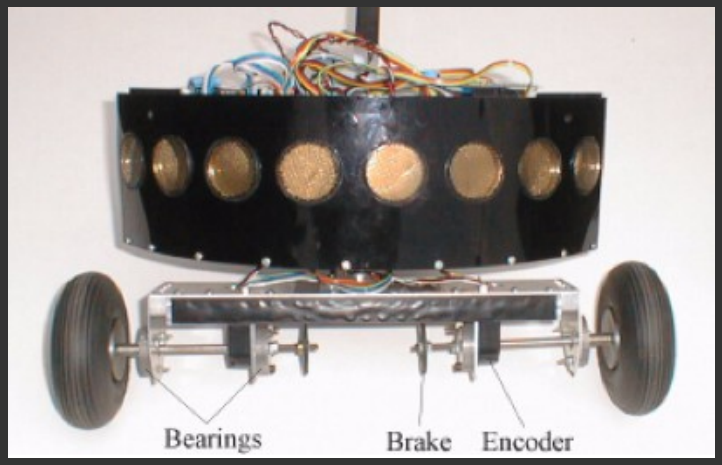
Haptics Based Systems

www.ultracane.com



Cardin et al., “Wearable Obstacle Detection System for visually impaired people”, VR, 2005

Other Approaches



Shoval et al., “Navbelt and the guide-cane”, IEEE Robotics Automation Magazine, 2003

Problem

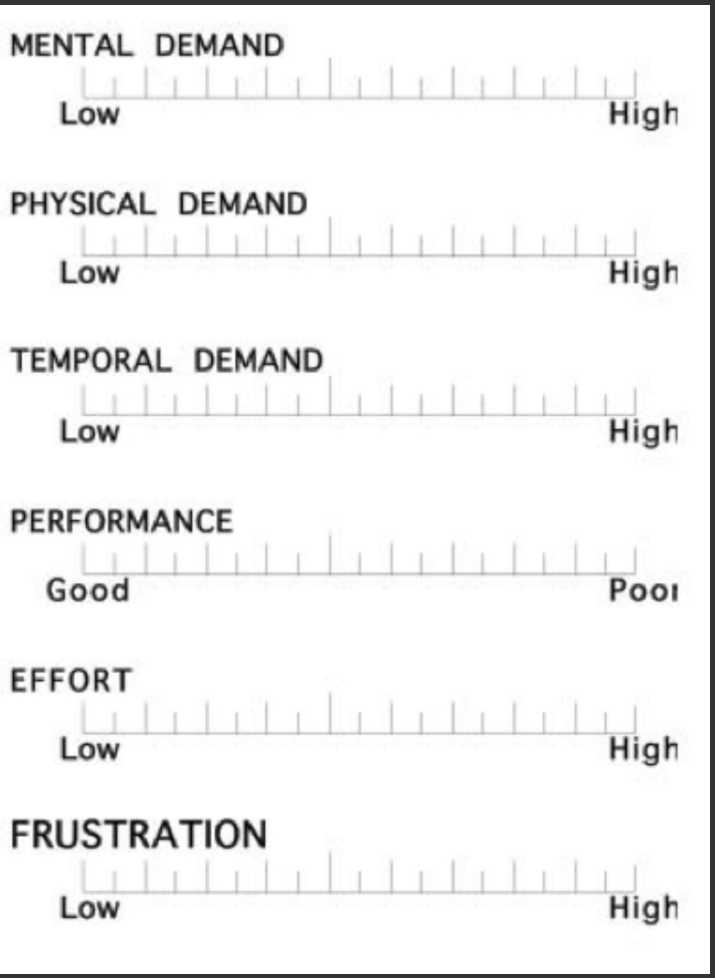
- There exists no definitive interface winner
- There is no common evaluation metric
- Therefore we suggest to use the NASA-TLX (**T**ask **L**oad Inde**X**) for evaluation

NASA-TLX

- Developed in 1986 at NASA's Human Performance Center
- One global score + six dimensions:
  - Mental Demands
  - Physical Demands
  - Temporal Demands
  - Own Performance
  - Effort
  - Frustration

NASA-TLX Paper & Pencil

RATING SCALE DEFINITIONS		
Title	Endpoints	Descriptions
MENTAL DEMAND	*Low/High*	How much mental and perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking, searching, etc.)? Was the task easy or demanding, simple or complex, exacting or forgiving?
PHYSICAL DEMAND	*Low/High*	How much physical activity was required (e.g., pushing, pulling, turning, controlling, activating, etc.)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?
TEMPORAL DEMAND	*Low/High*	How much time pressure did you feel due to the rate or pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?
EFFORT	*Low/High*	How hard did you have to work (mentally and physically) to accomplish your level of performance?
PERFORMANCE	*Good/Poor*	How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?
FRUSTRATION LEVEL	*Low/High*	How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?



Experimental Setup

- Obstacle course: 8 obstacles form a maze (20m x 5m)
- We assume a working system that detects those obstacles and guides the user around the maze
- One hour per test user to familiarize with the test

Color Finder

- Detects obstacles at 30Hz feedback with 5-20ms latency
- We manually signaled obstacles in cases of illumination or communication problems

Schauerte et al., “An assistive Vision System for the Blind that Helps Find Lost Things, ICCHP 2012

Audio Interface

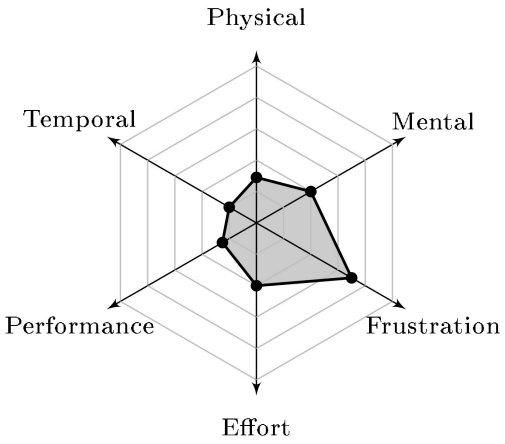
- Open headphones (others possible)
- 20ms beeps at 800Hz
- Horizontal image coordinate → sound panorama (pitch change removed)
- Up to 4 items could be differentiated by focused testers

Haptic Interface

- Custom lightweight and small electronics
- Vibration motors and bluetooth module
- Mounted to white cane, vibration bursts signal obstacle in front of user (left/center/right)

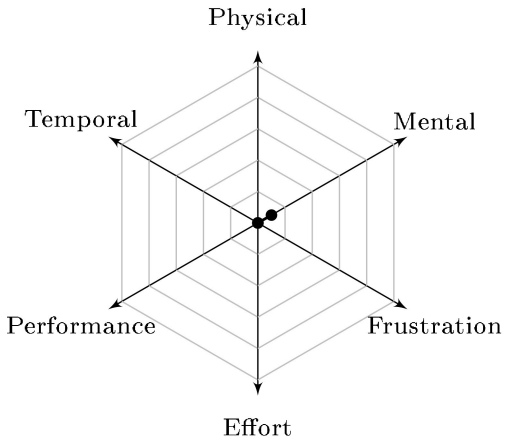
Workload Results

74.7%



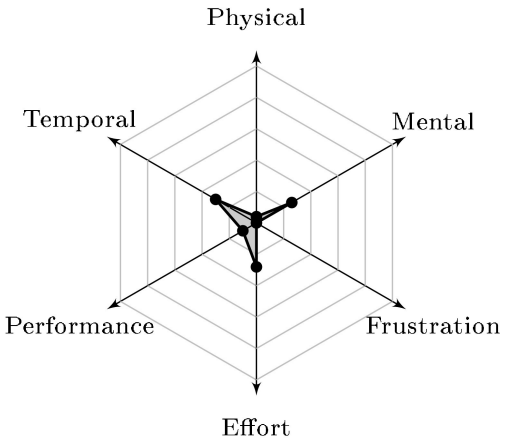
(a) White Cane Users - Audio

3.3%



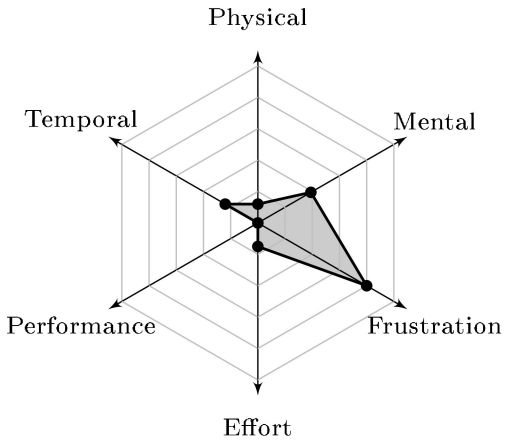
(b) White Cane Users - Haptic

32.6%



(c) Non White Cane Users - Audio

56.0%



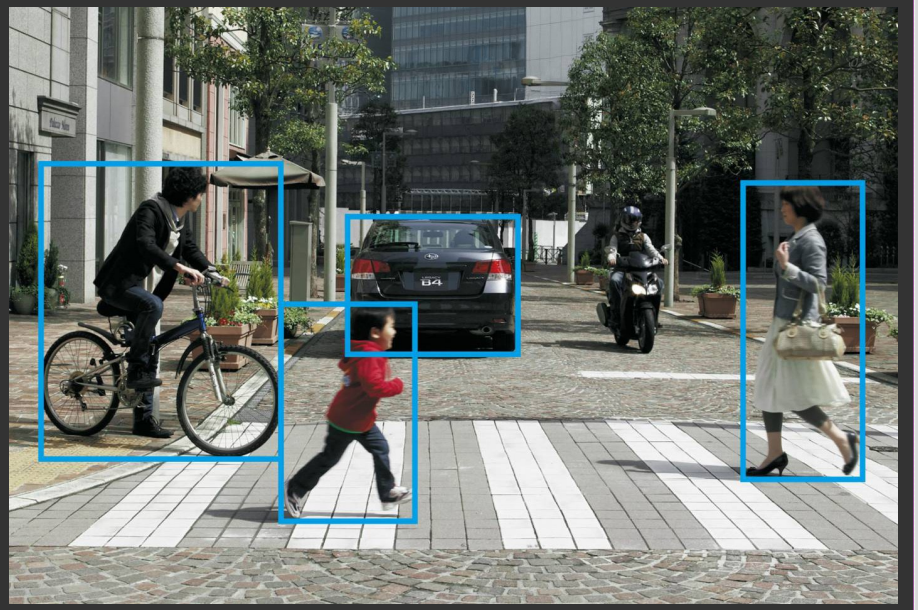
(d) Non White Cane Users - Haptic

Conclusions

- We suggest the NASA-TLX as a valid and proven metric to evaluate user interfaces for the blind
- Blindfolded users are not the best candidates to evaluate navigation interfaces
- Such systems should be evaluated in a mix of blind and blindfolded users

Future Work...

- Part of a bigger research prototype
- Obstacle avoidance and navigation
- Person identification
- Context in navigational situations on a local scale
- Further study feedback options



Questions?

- Thank you for your attention!