

Distance Encoding in Vibro-tactile Guidance Cues

Motivation:

To navigate in unfamiliar places is, for obvious reasons, particularly difficult for blind people. We first created an indoor navigation system with a very simple notification pattern and then tried to improve walking speed and accuracy by adding distance information.

System Description:

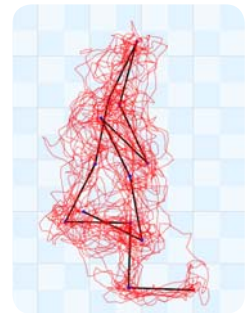
We used the 6-DOF ultrasonic tracking system InterSense IS-900 and a vibro-tactile waist belt composed of 8 C-2 tactor elements from Engineering Acoustics Inc. For the design of the vibro-tactile cues the following parameters have been used: intensity (attenuation in dB), frequency, position (which tactor), pattern.

Routes in series A had 13 equidistant (1.5m) waypoints, in the second series (B) the overall length was 13.5m (also with an average distance between waypoints of 1.5m). To guarantee unimodal feedback we masked the noise generated by vibrating tactors with music.



Traces of one participant of B1

Traces of all participants of A2



Experiment Setup:

Tactograms are defined via frequency, attenuation and vibration mode. When frequency or attenuation have a range of i.e. 200Hz – 300Hz, this means the following: If the par-

ticipant is 1.9m or more away from the waypoint, vibration frequency is 200Hz. When further approaching the waypoint frequency will raise until 300Hz directly at the waypoint.

A1 Fixed Frequency & Intensity

- baseline experiment
- tactogram: 250Hz, -0dB, continuous
- latency: approx. 750ms

A2 Varying Frequency & Intensity

- distance encoding experiment
- tactogram: 200Hz – 300Hz, -24dB – -0dB, continuous
- latency: approx. 750ms

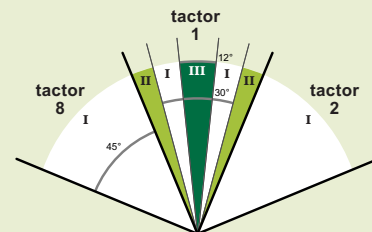
B1 Fixed Frequency & Intensity

- baseline experiment
- tactogram: as in A1
- latency: approx. 250ms

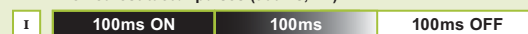
B2 Varying Frequency & Pattern

- distance encoding experiment
- tactogram: 250Hz – 320Hz, -0dB, in patterns
- latency: approx. 350ms

Vibration pattern I is used as guidance cue for tactors 2 to 7 and the white areas of the front tactor (1), two additional cues are used for the front tactor: II - turn left/right slightly and III - waypoint is straight ahead.



The nearest tactor pulses (300ms, B2):



The front tactor vibrates (300ms, B2) together with



the adjacent tactor (300ms, B2):



The front tactor vibrates in double pulses (300ms, B2):



Vibration patterns: In segments with a b/w gradient the tactor state (on/off) depends on the distance to the next waypoint (1.9m are linearly mapped to 100ms).

The nearest tactor vibrates without pause (A1-B1):



Special waypoint notification (400ms, A1 - B2):

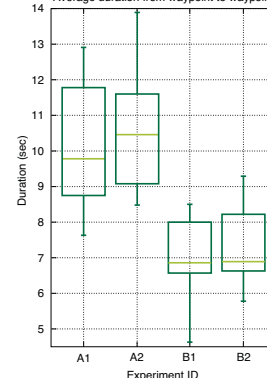


Results:

Our results do not encourage the encoding of distance information in vibro-tactile guidance cues. **We could not show that distance information improves accuracy in finding waypoints.** Performance in A2 was worse than in A1 due to vibrations being difficult to sense at -24dB. B2 did not show significant improvements over B1, even if the walked average distance was slightly smaller. Nevertheless, participants were able to follow the waypoints quite well, especially in series B with its low latency.

We still believe that distance information is important – especially for longer walks and for blind people who can not see their destinations. The next step in our research will be the implementation of a system for the guidance of blind people on our campus.

Average duration from waypoint to waypoint



Average walking distance between 2 waypoints

