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Distance Encoding in Vibro-tactile Guidance Cues

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Vibro-tactile Guidance: **Problem Statement, Setting**

Known difficulties of navigation in unfamiliar places or in harsh environments

- **Traditional approach:** Guidance with visual and/or auditory sensory channels.
- **Problems**
 - Sensory channels are often **overloaded**.
 - **Physical properties** limit perception capabilities (e.g. reflecting light, smoke or fog for the visual channel; plenty of overlaid sources of auditory information).
 - Eyes, ears, and/or hands are **inaccessible** (used for other tasks).
- **Particularly of interest: Disabled (blind) people** (cannot unfold a map...).

Hardware setting

- Vibro-tactile notifications with a "**tactor belt**" (8 tactile actuators, \varnothing 30mm, 200 - 300Hz resonance, 180ms controller latency, Bluetooth connection).
- Wireless ultrasonic **position/orientation tracking system** (Intersense IS-900).
- Music played via headphones to mask vibration noise.



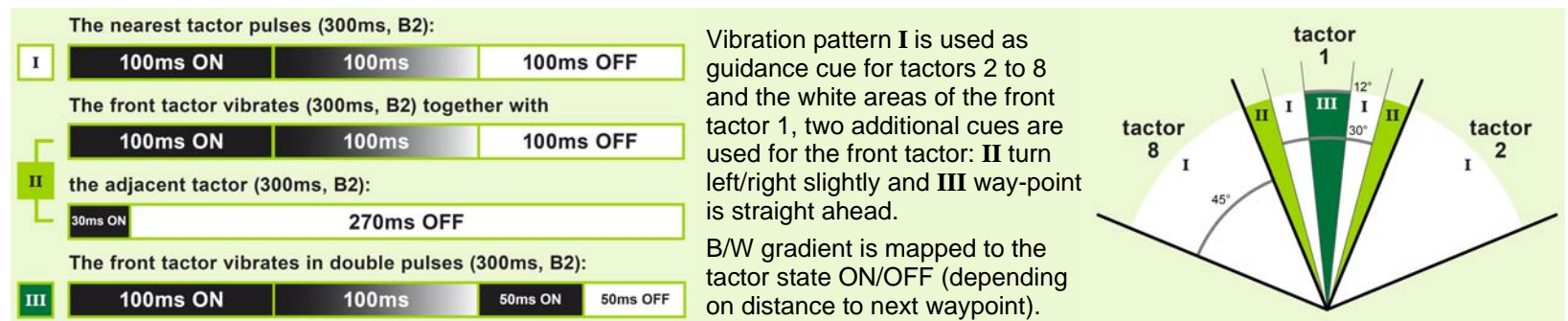
Vibro-tactile Guidance: **User Studies**

Experiments

- Variation Parameters (**parametrization**): (i) vibration intensity (attenuation), (ii) vibration frequency, (iii) vibration mode (tactile patterns or **Tactograms**), defined by pulse-pause times, latency, etc.

Different distance encoding schemas

- Basic series (750ms system latency)
 - (A1) **Baseline**: Fixed frequency (250Hz), fixed attenuation (-0db), sustained vibration.
 - (A2) **Distance encoding**: Frequency range 200 - 300Hz, attenuation range -24db to -0db, sustained vibration.
- Advanced series (reduced system latency, 250ms)
 - (B1) **Baseline**: as above (A1).
 - (B2) **Distance encoding**: Frequency range 250 - 320Hz, fixed attenuation (-0db), different **Tactograms** dependent on **distance** and **direction** of next waypoint.



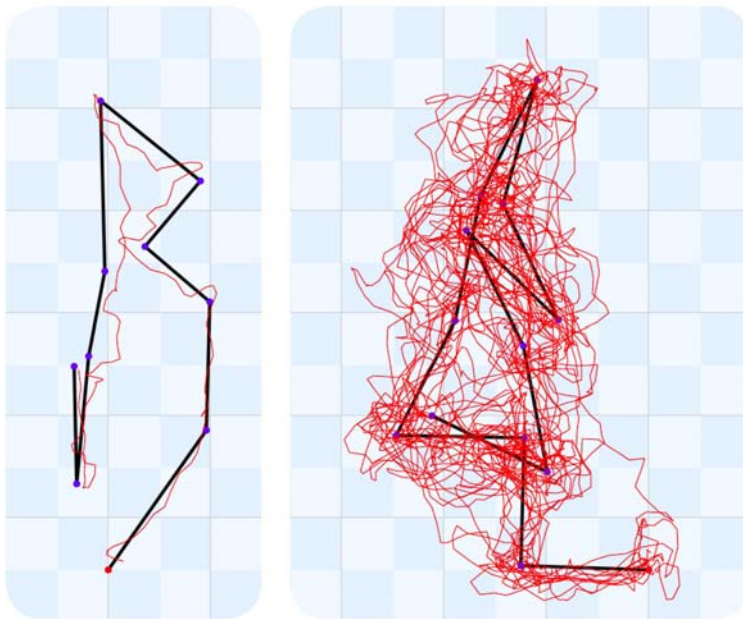
Vibro-tactile Guidance: Results and Conclusion

Orientation information is important for accurate route-guidance

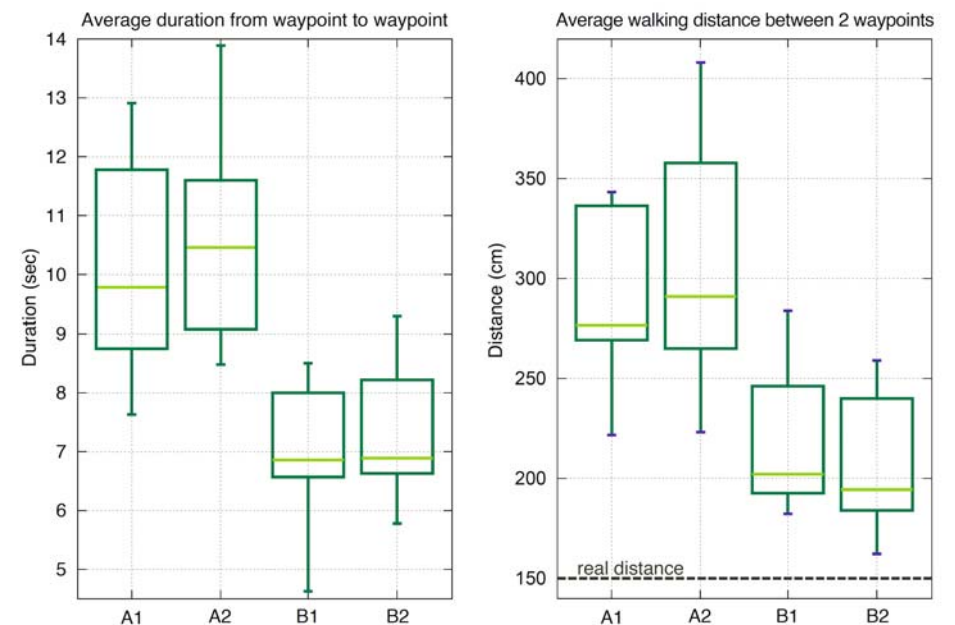
- Test participants were able to **follow the waypoints** quite well (low variation).
- **Distance information** does not improve the walking accuracy much (A1, A2).
- **System latency** directly affects walking performance (A, B series).

Next steps

- Larger **studies with blind people**.
- Installation/evaluation of WLAN-based **campus navigation**.



Trace of one test participant (left) and the overlay of traces from 11 attendees (right) gives an indication on system-performance.



Boxplots shows average duration (left) and walking distance (right) for all of the 4 experiments.