Navigation with auditory cues in virtual environment

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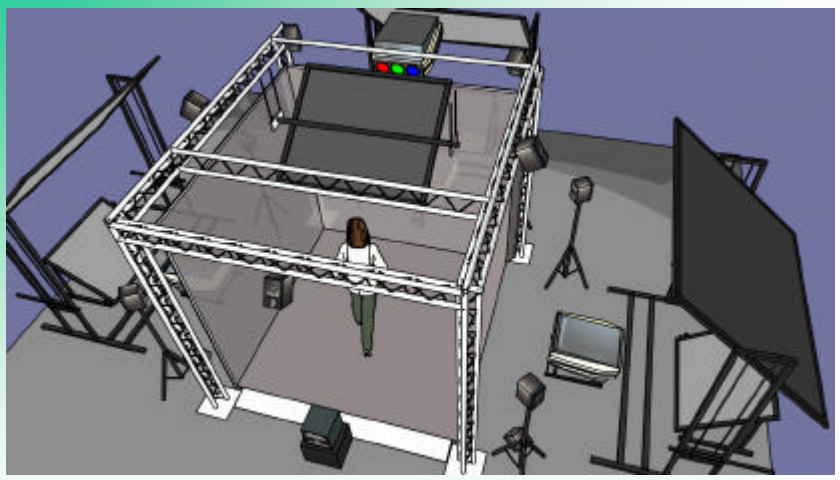
Agenda

- Experimental Virtual Environment (EVE) at HUT
- Navigation test
- Experiment 1, auditory / visual / audio-visual cues
- Experiment 2, navigation with auditory cues
  - Four different cue signals
- Conclusions

EVE at HUT, http://eve.hut.fi



14-channel 3-D audio reproduction with
Vector Base Amplitude Panning (VBAP)

Navigation tests

- Question: how well people can navigate in virtual environments with different kind of cues ?
  - A game-like test
  - Task: Find as many gates (markers) as possible
  - All aspects randomized
    - index of the first gate
    - travel direction
    - stimulus order
  - Finding of the gate was indicated with auditory signal
  - Only one gate at a time was visible/audible

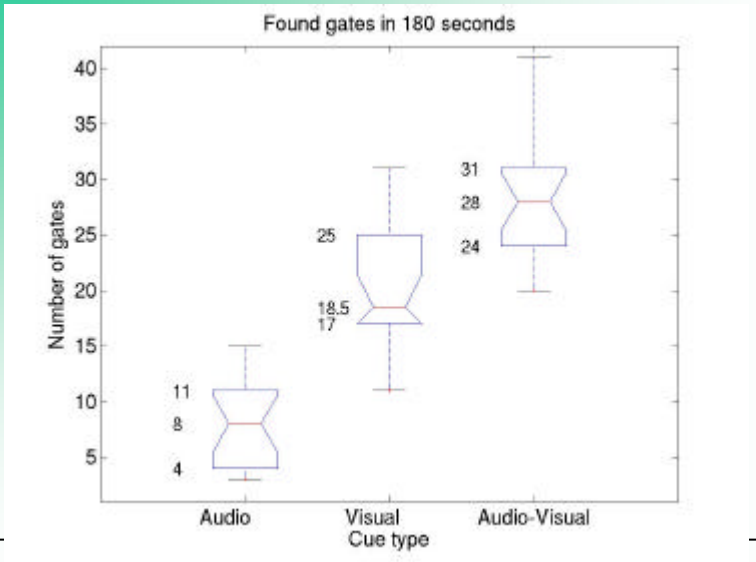
Audio-Visual experiment

- Subject followed the predefined track gate by gate

3 different stimuli:

- Auditory
  - Pink noise bursts with *1/r*-law distance attenuation
- Visual
  - White ball
- Audio-Visual
  - Both stimuli

Experiment 1, 9 subjects, 2x3 stimuli



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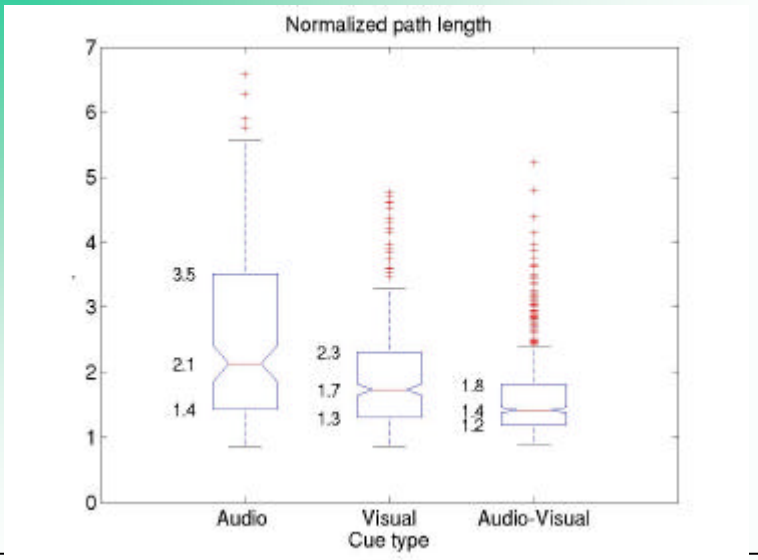
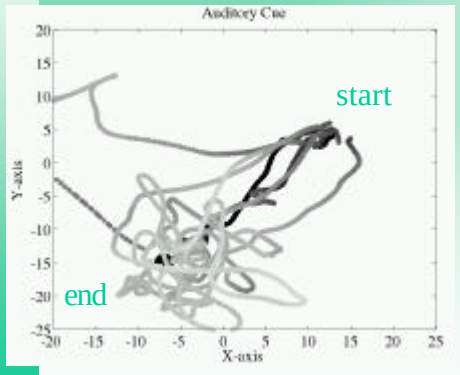
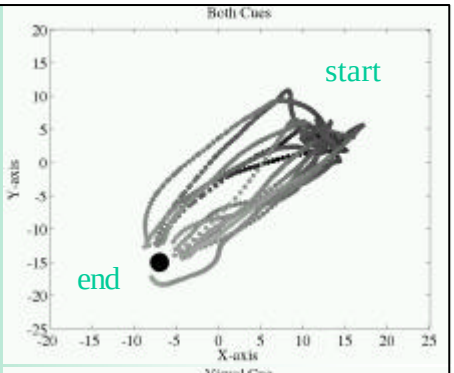
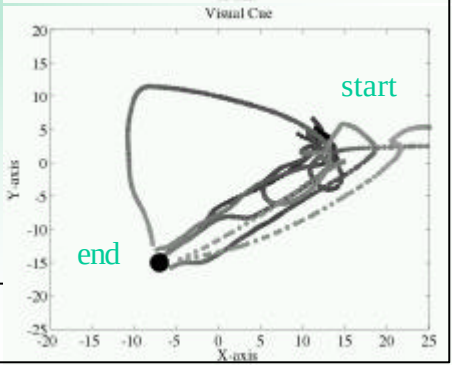


Paths for one gate pair



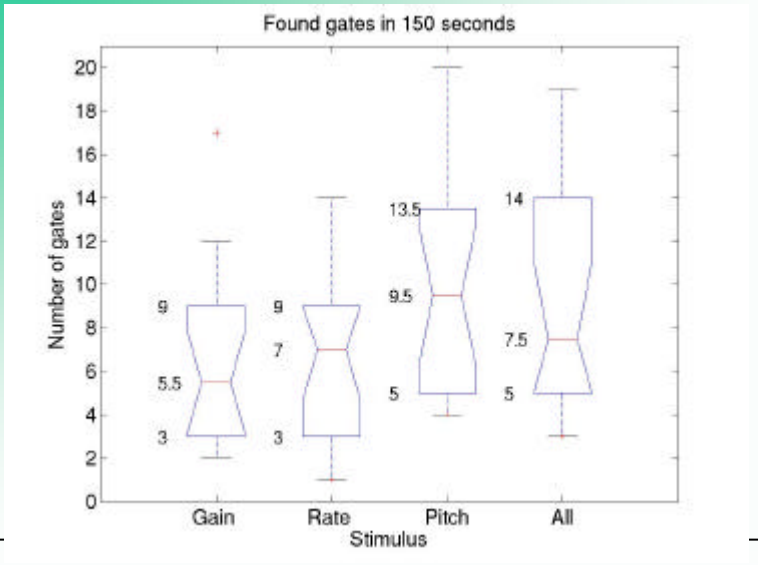




Experiment 2

- Navigation with auditory cues only
- Stimuli, based on pink noise bursts
  1. ***gain***, same than in experiment 1
  2. ***rate***, density of burst indicated distance to next gate
  3. ***pitch***, noise bursts + narrow band noise,
     - the center frequency indicated the height of the sound source
  4. ***all***, gain + rate + pitch
- In *pitch* and *all* the elevation information is encoded to the stimulus signal
- One race 2 min 30 sec.

Experiment 2, 8 subjects, 2x4 stimuli



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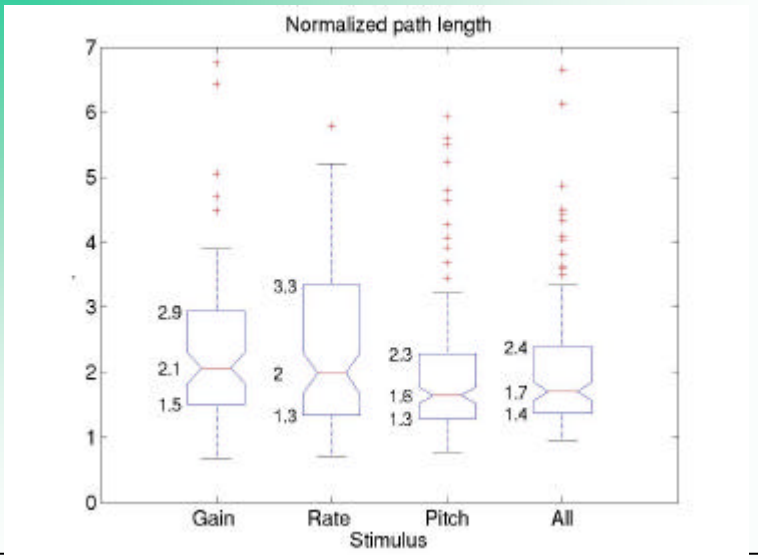
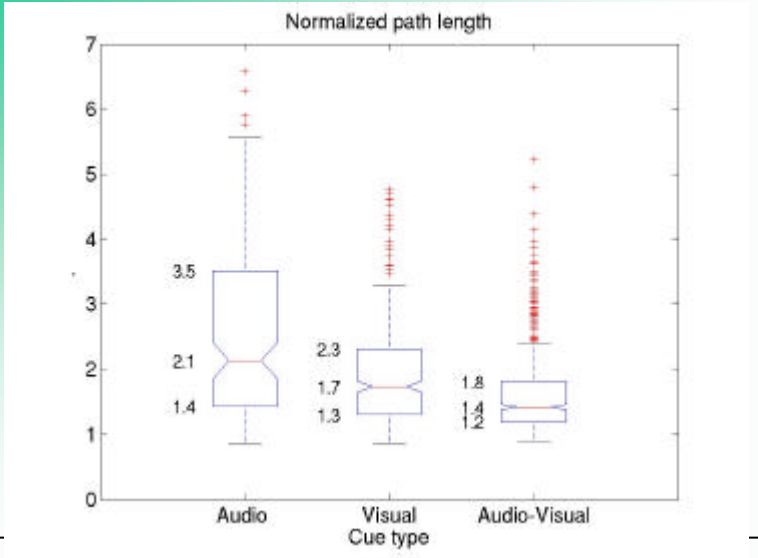


Experiment 1, 9 subjects, 2x3 stimuli



Summary

- Navigation in 3D virtual environment
  - The best performance with audio-visual cues
  - Auditory navigation possible
    - Careful audio signal design helps
- Possible applications
  - Navigation without visual cues
    - Fire simulations
    - Architectural walk-throughs
    - Etc.
  - Object “highlighting”

Navigation experiments - summary

- Experiment 1
  - Audio-visual cues were remarkably better than auditory or visual cues alone
    - Auditory cue was utilized to define the approximate location of the gate
    - Visual cue was utilized in the final approach
  - Auditory navigation possible even in 3D
- Experiment 2
  - When elevation information is encoded to the cue signal, navigation is easier
- 3D audio can help in navigation, in “highlighting” objects, etc.