Evaluating Reaching & Tapping Motions in 3D Interfaces

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Introduction

Object selection through reaching to/ touching objects in VR

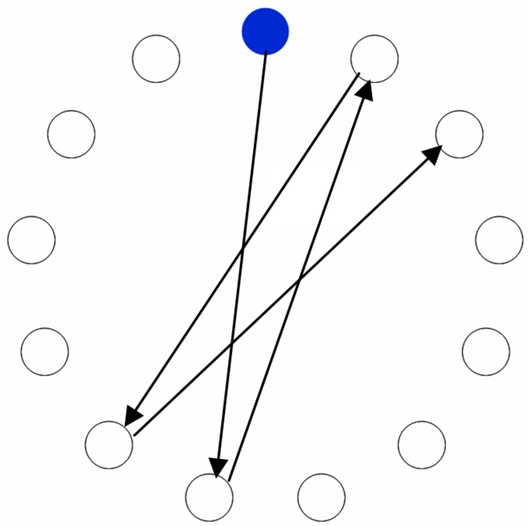
Fitts' law and ISO 9241-9

- Movement time (*MT*) depends on target distance (*A*) & width (*W*):

$$MT = a + b \cdot \log_2\left(\frac{A}{W} + 1\right)$$

- Throughput (*TP*):

$$TP = \frac{\log_2\left(\frac{A_e}{4.133 \times W_e} + 1\right)}{MT}$$



ISO 9241-9 task, in 2D. Target order for first 5 shown.

Research Questions

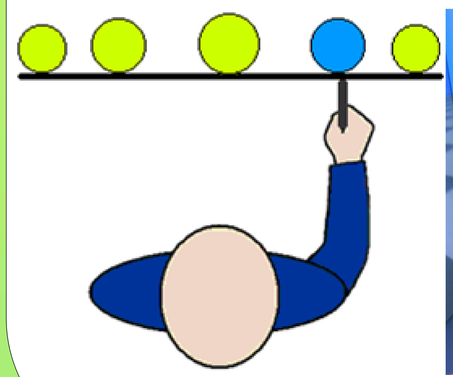
- VR studies hard to compare →
  - ISO 9241-9 & throughput
- Does Fitts' law model 3D motion?
- What affects 3D task performance?

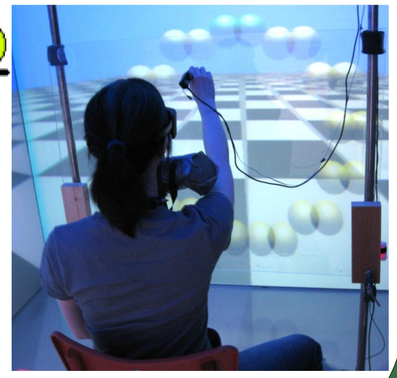
Haptic Feedback Study

Does haptic feedback affect throughput?

Experiment

- Tracked stylus with stereo in CAVE
- Clear plastic panel for haptic feedback
- 2 conditions (haptics present or not) x 3 target diameters x 3 distances x 3 repeats





(Left) Top view. (Right) Participant performing the task.

Results

Movement time – not significant

- With haptics 1.59s, without 1.60 s

Error rate – not significant

- With haptics 11.1%, without 13.3%

Throughput – **significant, $p < .05$**

- With haptics 2.56 bps, without 2.37 bps

Conclusion

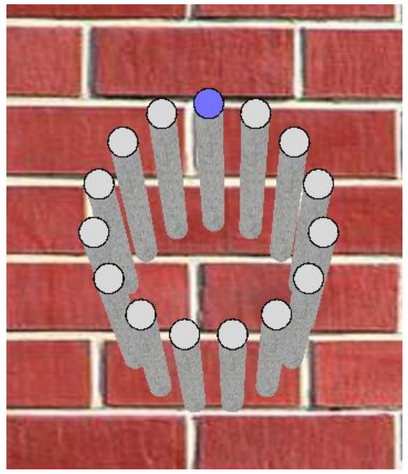
- Throughput illustrates difference better
- *But…* not a true 3D task: targets in plane

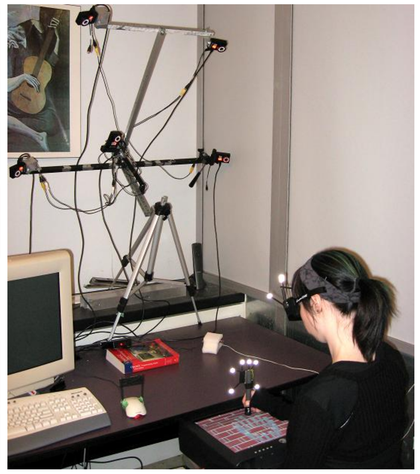
Fish Tank VR Study

Does 3D position affect pointing?

Experiment

- Fish Tank VR with tracked stylus
- ISO 9241-9 targets at varying height
- Stereo view with head-tracking
- 4 target plane heights x 3 distances x 3 diameters x 3 repeats





(Left) Selection task. (Right) Participant performing the task.

Results

Fitts' law better modeled MT closer to screen

- Correlations higher

Throughput – **significant, $p < .0005$**

- Generally closer to screen → higher TP

Conclusion

- Higher targets are harder to hit