Evaluating Visual/Motor Coupling in Fish Tank VR

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Introduction

- Virtual reality (VR) often co-locates input and display
  - Goal: Directly manipulate objects, as in reality
  - Does this improve performance?
- Desktop interface uses disjoint input/display space

Fitts' Law and Pointing

- Fitts' Law predicts movement time (*MT*) of rapid aimed movements:

$$MT = a + b \cdot ID \qquad \text{where} \qquad ID = \log_2\left(\frac{D}{W} + 1\right)$$

- *D* is distance to target, *W* is size (width) of target
- *ID* is Index of Difficulty → overall task difficulty
  - *Smaller, farther objects are harder to hit*
- Strong predictive capabilities

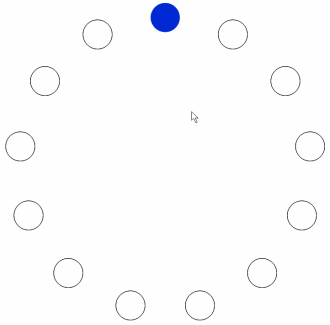


Figure 1. 2D pointing task, from ISO 9241-9, compares pointing device performance.

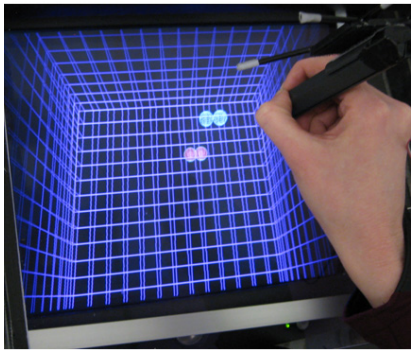
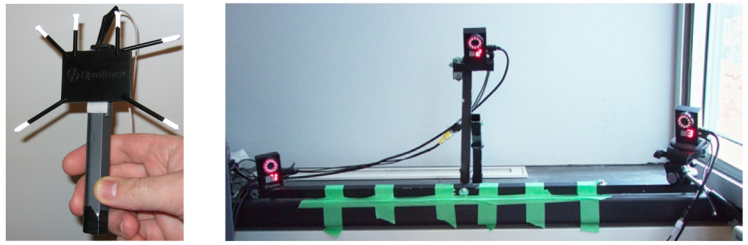


Figure 2. Our new 3D pointing task. Required clicking and dragging of objects with tracked stylus.

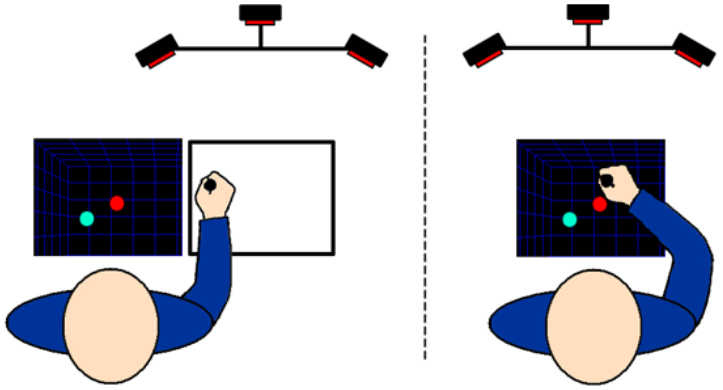
Experiment

- User study using object movement task (Fig. 2)
- Used stylus (Fig. 3a), tracked by *OptiTrack* (Fig. 3b)
- Co-located vs. disjoint working space (Fig. 4)
- Movements comprised of all directions along each of *x*, *y* and *z* axes from centre
- Stereo to enhance depth perception



(a) (b)

Figure 3. Equipment used in the study. (a) Tracked stylus, with pen button (under the thumb); (b) NaturalPoint *OptiTrack* – optical tracking system.



(a) (b)

Figure 4. (a) Disjoint condition: required working in a space separate from the display; (b) Co-located condition: the display was under the working space. The display was moved away from the working space in the disjoint condition.

Results

- No sig. diff. in speed between co-located and disjoint
- Movement into the scene (down on *y* axis) found to take longer, in general, but significantly longer in disjoint
- Differences found by direction of movement
- Results likely due to lack of effective depth cues