Introduction to Computer Input Devices and Their Evaluation

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First Mouse Patent (Engelbart, 1964)
First Mouse (Douglas Engelbart and William English, 1964)
A Variety of Input Devices

- Mouse
- Stylus
- Touchscreen
- Touchpad
- Joystick
- ...

...
Performance Evaluation

- “I like it!” / “It is cool!” is not enough
  - “Perception is not always reality”
  - Conscious articulation is not always behavior
    (describe how to ride a bike)
- Complexity of human behavior/performance beyond analyses
- Individual differences
- Objectivity
- Making HCI an empirical (good) science
- Iterative Design
Iterative Design

- Observation / idea
- Design/implementation
- Performance Evaluation
- Product/Knowledge

- Evaluation for insights
- Evaluator vs. designer
Qualitative Analysis

- Touchscreen
  - Pros
  - Cons
- Stylus / light pen
  - Pros
  - Cons
Quantitative Performance Evaluation

What to measure?
- Depending on the task / application scenario

Common measures
- Trial completion time
- Error rate
- Learning speed
- Comfort / fatigue
- etc.
Pointing Device Evaluation

- **Real task:** Interacting with WIMP interface
- **Experimental task:** target acquisition
  - abstract, elemental, essential
- **Performance measures:** time, error rate
Task modeling for evaluation

- Bring task modeling to device evaluation
  - Card, English, Burr, 1978

  “Evaluation of mouse, rate controlled isometric joystick, step keys and text keys for text selection on a CRT”,

  *Ergonomics*, vol. 21, 601-613
**Fitts’ law** (Paul Fitts, 1954)

\[ MT = a + b \log_2 \left( \frac{D}{W} + 1 \right) \]

1/b - Index of Performance, Throughput, Bandwidth
Fitts’ law

- “The information capacity of the human motor system in controlling the amplitude of movement”,

*Journal of Experimental Psychology, vol 47, 381-391*
Experimental Design

- **Fairness for the given task**
- **Wide enough ID combinations**
  - W’s: from character size (10) to icon (30 pixel)
  - A’s: from short (60) to cross screen (800)
- **Multiple individuals/subjects**
- **Balancing orders**
- **Statistical analysis**
- **Controlling error (about 5%)**
THE INFORMATION CAPACITY OF THE HUMAN MOTOR SYSTEM IN CONTROLLING THE AMPLITUDE OF MOVEMENT

AUL M. FITTS
Ohio State University

...ently ever, by asking S to make rapid and ... that have been ... and by holding all...
Lab Assignment

- Measure Fitts’ law index of performance with bare hand on paper
- Measure any two devices using Fitts’ law with the Almaden Program
- Compare performance of the two devices
- Compare devices with bare hand
- Discuss the validity/benefits of Fitts’ law in your study.
- Discuss pros and cons of the devices: suggest improvements or new designs
Beyond Fitts’ law

- Hick’s law
- Key stroke model
- Control theoretic modeling
- Limitations to Fitts law: pointing only
Trajectory-based tasks

- Example: hierarchical menus
- Is there a “law” to Steering?
Thought experiment...

- **2 goals passing**
  \[ ID = \log_2 \left( \frac{A}{W} + 1 \right) \]

- **3 goals passing**
  \[ ID = 2 \log_2 \left( \frac{A}{2W} + 1 \right) \]

- **N+1 goals passing**
  \[ ID = N \log_2 \left( \frac{A}{NW} + 1 \right) \]

- **∞ goals passing**
  \[ ID = \frac{A}{W} ? \]
“Steering law”

- Steering law (Accot and Zhai 1997)
  - “Beyond Fitts’ law: Modeling trajectory based HCI tasks”, *Proc of CHI’97*

\[ T_C = a + b \ ID_C \]

\[ \mathcal{I} \mathcal{D}_C = \int_{C} \frac{dx}{W(x)} \]
Results
Device comparison in steering tasks

(Accot & Zhai, CHI’99)

Steering Index of Difficulty

Time

5 10 15 20 25 30

Trackball
Touchpad
Trackpoint
Mouse
Stylus
Conferences and Journals

- CHI: ACM Conference on Human Factors in Computing Systems
- INTERACT: IFIP Conference on Human Computer Interaction
- UIST: ACM Symposium on User Interface Software and Technology
- HFES: Human Factors and Ergonomics Annual Meeting
- ACM Transactions on Computer Human Interaction (TOCHI)