Sketch vs. Drag-and-Drop Input on a Pen-Based Tabletop Display

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Goal
• Investigate the usability of the two most basic pen-input methods, drag-and-drop (DnD) and sketch, on a tabletop display in an emergency response setting.
• Provide a guideline to system designers building pen-based tabletop applications, especially with sketch recognition ability.

Experiment
• 36 Participants (21 males, 15 females)
• 4x4x3 Partially-crossed mixed repeated-measures ANOVA

Three Independent Variables:
1. Input mode: 4 conditions
   - drag-and-drop: tree and palette symbol menu
   - sketch: low (75%) and high (90%) recognition accuracy
2. Sketching complexity: 4 conditions
   - 20 symbols are categorized according to the drawing time
3. Frequency of use: 3 conditions
   - Low (symbol used once), Med (3 times), High (5 times)

Three Dependent Variables:
1. Location accuracy
2. Task completion time
3. Preference

Scenario
Simulated emergency response: operators in a command center populate a tabletop display map with critical incident icons.

Tabletop Display
• Four mechanically aligned projectors, 2560 x 2048 resolution in total.
• 3.6’ x 5’ digitizing surface, stylus
• Digitizer coordinate system calibrated to image coordinate system

Testbed Application
• Emergency response scenario, 1600x1400 pixel map.
• Provides two input modes: DnD and sketch.
• We measure task completion time and location accuracy.

Sketch Recognizer for Training
• Recognizes hand-drawn symbols and replaces them with image symbols.
• Used only for training session. Test sessions used a simulated recognizer, to allow precise control of accuracy rate.

Result
• Location accuracy
  - Participants using DnD made significantly more location errors (6.07%) than those using sketch (3.57%) ($p=0.006$)
  - In an emergency response setting, accuracy is crucial.
• Task completion time
  - DnD was significantly faster than sketch.
  - Sketch can be competitive if symbols are simple to draw and easily remembered.
• Preferences
  - DnD was significantly preferred over sketch.
  - Participants felt that a pen-based copy/paste gesture would substantially reduce the sketch workload when the same symbol needed to appear repeatedly.

Future Work
• Test how the number of symbols affects operator performance (full set contains ~200 symbols)
• Test hybrid approaches: multimodal input, hierarchical marking menu, single-stroke shortcut sketch input, etc.