Investigating Multi-Touch and Pen Gestures for Diagram Editing on Interactive Surfaces

Mathias Frisch, Jens Heydekorn, Raimund Dachselt
User Interface & Software Engineering Group
University of Magdeburg, Germany
Outline

- Motivation
- Design of the pilot study
- Results
- Observations & Discussion
- Conclusion & Future Work
Motivation
Motivation – Creation of Diagrams

- **Diagram Sketching:**
  - On whiteboards, flip charts or paper
  - Content has to be remodeled in digital tools

- **Applications for electronic whiteboards or Tablet PCs**
  - [Damm et al. 2000], [Chen et al. 2003], [Grundy et al. 2007]
  - Ad-hoc sketching + additional digital features
Motivation – Creation of Diagrams

- Structural Diagram Editors:
  - Point & click, dragging elements from toolbar...
  - Diagrams conform to semantic rules
  - Often conceived as inflexible and constrictive
    [Damm et al. 2000], [Grundy et al. 2007]
Our Approach

- Combination of multi-touch and pen gestures on interactive surfaces for diagram editing
Our Approach

- As a starting point:
  - User-centered design approach to develop basic gesture set for further research

- Pilot study to elicit gestures from users
  - Similar to design as applied by [Epps et al. 2006] and [Wobbrock et al. 2009]
  - Considering
    - touch interaction (*structural editing*),
    - pen input (*diagram sketching*),
    - combination of both
  - No unambiguous user-defined gesture set without conflicts
Questions to clarify

- Will there be a high level of agreement between users?
- For which tasks will bimanual interaction be preferred?
- What is the nature of the performed gestures?
- Will gestures be distinguishable for all tasks?
- Will the pen be used in combination with the non-dominant hand?
Participants performed gestures in the lower area
- Conditions: One-handed,
  Two-handed,
  Pen (supported by hand if necessary)
- Free choice of interaction technique to start with
- Suitability questionnaire after each task
Method

- 14 basic diagram editing tasks
  - Create and delete nodes/edges, copy sub-graph...

- 17 Participants
  - Solid background in software engineering
  - Knowledge of modeling tools
  - Within-subjects design

- Apparatus
  - Tabletop display (1280x800)
  - Capturing of the gestures by video, tabletop vision system, taking notes
  - Pens with IR source
Results – Gesture Analysis

- 658 gestures recorded
- 26 abbreviations to group equal or very similar gestures
  - discrete and continuous actions
  - sequential and parallel actions
  - pen-only gestures and pen gestures supported by hand
- Amount of gestures for each task show level of agreement
Results – Gesture Analysis

- select node
- create undirected edge
- create directed edge
- move single node
- change to dashed edge
- move group of node
- create two directed edges
- create nodes
- select group of nodes
- zoom diagram
- delete nodes
- delete edges
- scale single node
- copy subgraph

One-Handed Interaction  Two-Handed Interaction  Pen/Hand Interaction
One-handed interaction: 141 cases (59%)  
Pen/hand interaction: 68 cases (29%)  
Two-handed interaction: 28 cases (12%)
Results – User Observations

- Diagram sketching & structural diagram editing
  - both applied where possible
- Desktop metaphor very dominant
  - especially for abstract tasks
Results – The Gesture Set

- Consideration of
  - First choice data
  - Suitability questionnaire
  - Structural editing / Sketching
  - more than one top candidate for each task

- Examples

Create node
Results – The Gesture Set

Create node
Create undirected edge
Create directed edge
Create two directed edges
Change type of edge
Copy sub-graph
Select node(s)
Move node(s)
Scaling & Zooming
Delete nodes & edges
Observations & Discussion

- 2 Categories of “sketching gestures”
  - Physical gestures
  - Metaphorical gestures
  - Abstract gestures

- Ambiguities
  - Conflicts mainly in abstract tasks
  - Users try to solve ambiguity by including context
  - Contextual help and disambiguation for simple but powerful gestures


Observations & Discussion

- Pen and Hand Interaction
  - Non-dominant hand in combination with pen hardly used (only 12 %)
  - Exceptions:
    - scaling and zooming tasks
    - non-dominant hand used for mode switches
  - Participants not used to combine both
  - Hardly distinction between fingers and pen
Unexpected gestures
  – Symbol drawn on background
  – Dragging to off-screen
  – Unrecognizable gestures (flipping hands, grasping...)

![Diagram of gestures]
Observations & Discussion
Observations & Discussion

- Unexpected gestures
  - Symbol drawn on background
  - Dragging to off-screen
  - Unrecognizable gestures (flipping hands, grappling...)
Conclusion & Future Work

- Contribution of a basic set of user-defined gestures for node-link diagram editing on interactive surfaces
- Pilot study to elicit hand and pen gestures from users
- Findings:
  - Requirement to equally support *diagram sketching* and *structural diagram editing*
  - Preference of simple gestures with disambiguation
  - Dominance of one-hand and pen-only interaction
  - Unusual gestures
- Next steps
  - Resolving conflicts + implementing the gesture set
  - Follow-up evaluation of the gesture set
  - Further developing and extending the gesture set
Thank you.

Mathias Frisch: mfrisch@isg.cs.ovgu.de
http://www.isg.cs.ovgu.de/uise/


