FACULTY OF ENGINEERING & IT

The Design of Touchable Interactions for Data Visualization

Thesis of Master by Research Degree

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CERTIFICATE OF ORIGINAL AUTHORSHIP

This thesis is the result of a research candidature conducted at University of Technology as part of Masters by research degree. I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as part of the Masters by research degree and/or fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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Abstract

Natural User Interfaces (NUIs) are gradually becoming universal in modern user interface design. Researchers are attempting to apply novel Computer-Human into the design of interactive data visualization. Touchable interaction, an affordable and relatively mature member of NUI, has drawn much attention in today's design of personal computers. And it has been proved to be effective and efficient in accomplishing some certain tasks, for example, pinch and stretch to zoom or scale. However, the values of Interactive Tabletops and Surfaces (ITSs) that could offer to the field of data visualization still remain unclear. The derived questions become how to best leverage touchable interaction into data exploration, navigation and manipulation.

We reviewed over fifty papers and proposed a classification of touch interaction styles, based on how fingers interact with data. And then we organized the literature review according to the proposed category. Following this, we listed where touch interaction outperforms desktop and mouse, along with where the limitations and tradeoffs are. Any combination of the merits or limits could become a research question, but we are only focusing on the ones applicable with tablet-sized touch screen.

As a pioneer research, we designed a set of gestural commands to replace keyboard-mouse interactions in DA-TU. Clustered graph visualization, such as DA-TU, has been successfully applied in the field of large scale relational data visualization for data analytics. But it was very inefficient in interactions, in which a control panel was required to swap among eight different modes of operation. The proposed design was implemented on iPad, and we conducted user tests to demonstrate its higher efficiency and better user experience.

Mouse hover is a common and effective solution in data visualization applications to deal with the "representation problem". We proposed an interaction technique named Radial Cursor to address this problem on touch screens. It stimulates 'mouse hover' interaction with radial hierarchical data, coupled with a level switch, Radial Cursor provide intuitive and effective controls of 'hover to see more detail' or 'hover to highlight' over every data node. We also applied real dataset to show that Radial Cursor helps user to quickly get a general sense of an unfamiliar dataset, or review an already-known dataset.

We integrated the methodology from visualization project design study, industry of Human-Computer-Interaction, and data analysis process. Hopefully our work can contribute to clarifying why we need touch displays to support data visualization, and how to best leverage touch interaction in visual data analytics tasks.

Keywords: interactive data visualization; multi-touch; natural user interface (NUI); playful data analysis; design research