Creative Drawing with Computers

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Abstract

The output of creative drawing is negatively influenced by any constraints imposed on the artist. That may be the case especially in computer-based environments. In my PhD research I focus on the identification and assessment of the influence computer input methods (i.e. mouse, stylus-, and touch-input) might have on the results of free-hand drawing tasks in terms of user's creativity and drawing performance.

Keywords

Shape, tracing, drawing, creativity, freehand, mouse, stylus, touch, evaluation, comparison, method

ACM Classification Keywords

H.5.2 [User Interfaces]: Evaluation/methodology, Input devices and strategies.

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CHI'12, May 5–10, 2012, Austin, Texas, USA.

ACM 978-1-4503-1016-1/12/05.

Context and Motivation

Increasing popularity of touch- or stylus-sensitive displays is changing the way people interact with computers during their creative or artistic endeavors. For example idea-sketching has an important role in the creative process in the early phase of design, therefore sketching behavior has been experimentally studied and idea-sketching is supported by many computerized tools [7]. Issues related to a use of computer input devices are among the core topics in Human-Computer Interaction (HCI) research. However, research on computer input methods was traditionally focused on performance aspects of navigational pointing or selecting tasks. User's creative approach demands more freedom and may be negatively affected by any constraints imposed. Therefore, traditional spatio-temporally restrictive HCI models cannot always be applied to predict more complex drawing tasks. In order to expand our knowledge about the influence computer input methods have on the user's performance in creative drawing tasks I decided to analyze the previous research, identify key issues, and design and perform a series of comparative experimental studies on computer supported drawing with a use of mouse, stylus-, and touch-input devices.

Background and Related Work

Any surface-based human input can be broken down to a time-series of 2D coordinates. Therefore, an analogy

of line tracing can be used to describe an outcome of the continuous user's action that takes place e.g. on a touch-sensitive surface. And while the 2D navigational task may be represented as line-tracing - line-tracing tasks should not be considered as navigation tasks. The main reason is that the line-tracing task represents different user's goal than getting from point A to point B as fast as possible - as it is in case of navigational tasks. Alas, only navigational tasks became the subjects of mathematical modelling. Proven methods like e.g. Fitts' Law have been formulated and can be used to model linear pointing and selecting tasks. However, not all users can always be modelled well this way and it also appeared to be not well suited for modelling two dimensional tasks. That has been supplemented by the Steering Law modelling two dimensional navigational tasks by considering them as a constrained motion within predefined tunnels of error.

Additionally, many input devices have been tested on their effectiveness in pointing, dragging, goal crossing and path steering navigational tasks and this knowledge has been used in many analyses and comparisons [1, 2]. However, artistic line drawing can be an example of a task which might be negatively affected by a low accuracy of the input method used for drawing but also by any kind of spatio-temporal constraints imposed on the user. I was unable to find a model suitable for spatially and temporally unconstrained freehand drawing with initially unpredictable user error and unknown mathematical formula describing the original path or shape. However, interesting corner-passing strategies have been observed by Pastel earlier in steering tasks [4]. Additionally, not imposing any spatio-temporal constraints on participants creates a space for

subjective operational biases towards speed or accuracy which may influence participants' performance [13]. Moreover, according to a previous research on visual feedback we have to acknowledge its role as an external aid in drawing task like in distributed cognition view of cognitive support [3] or as a trigger of difference-sensing and difference-reducing feedback mechanisms of human mind as in the computational theory of mind [5].

As a measure of user's creativity in drawing tasks I decided to use a computerized version of figural part of the Torrance Tests of Creative Thinking (TTCT). The TTCT was developed in 1960s and its Figural part has two forms with three subtests: "Compose a drawing", "Finish a drawing", and "Compose a different drawing basing on parallel lines or circles". The TTCT's scoring procedures provide the assessment of four principal cognitive processes of creativity: Fluency - number of relevant responses, Originality - novelty of unusual but relevant responses, Abstractness of Titles - a verbal measure, Elaboration - the number of details used to extend a response, and Resistance to Premature Closure - a person's ability to stay open and tolerate gestalt ambiguity. The outcome of the figural TTCT has a form of the Creativity Index (CI) score obtained by each participant.

Research Problems, Objectives, and Methods

To assess to what extent the mouse, stylus-, and touch-input devices affect user's performance and creativity in drawing tasks I have formulated a set of problems I need to address experimentally:

- *Input device effect.* Participants are expected to perform differently using each input method which should be reflected in their scores (time, error, CI).

- *The shape effect.* The properties of shapes drawn are expected to have an impact on the performance results (time and error).
- *Visual feedback effect.* The results of previous experiments on interaction feedback [6] allow to expect a positive influence of its presence (time and error).
- *Subjective operational bias.* The participants are expected to set a unique individual ratio of speed to accuracy (time and error).
- *Measured vs. perceived performance.* Comparison of the quantitative results from the measurements with participants' opinions from qualitative post-test forms.

The problems above are mostly exploratory in nature and their impact has to be evaluated in a series of laboratory experiments:

- *Replication of semi-random shapes.* To compare the influence of the input method on participants' performance (time and error) in unconstrained free-hand tasks. A few of within-subject studies testing different shapes.
- *Solving the TTCT.*

The expected outcome of my research is one or more methods to evaluate the user's error in shape-replication tasks. These have to be created and the results can be compared post-hoc to predictions of the Steering Law model. I expect to find a method for identifying the most cumbersome elements of the randomly generated and complicated shapes. I will take advantage of the fact that the figural part of the TTCT is a method that provides the participant with the drawing situation and additionally offers a

standardized measure of the participant's creativity. I will check if the patterns in user's performance scores found will translate to the differences in the results of users' creativity tests when they use the input methods in question.

Research Situation and Dissertation Status

I am in the middle of my doctoral studies at the Department of Informatics and Media which is a part of the Faculty of Social Sciences at Uppsala University in Sweden. The thesis is aimed to be a compilation of published manuscripts.

By now, I have already conducted a series of laboratory experiments. The results from shape-replication tests and proposed methods of error evaluation have been published as conference notes [8, 9, 11]. The preliminary observations include:

- *Time.* Mouse is the most slowly and Touch is the most quickly used input device.
- *Error.* Touch is the least and Pen is the most accurate input device. These results are highly affected by the method used for error estimation, shape used, and users' subjective operational bias.
- *Visual feedback.* No effect of visual feedback on the task time or user's error.

The results from creativity assessment have also been published as conference notes [10, 12]. The preliminary observations include:

- *Creativity score.* No effect of the input device used nor any difference between the stylus and regular pen.
- *User Interface (UI).* An impact of UI is expected.

Expected Contributions

Creativity is the basis for inventive problem solving. I find it necessary to identify the effective ways to support user's creativity in computer-based applications like creativity tests or brainstorming facilitating tools. I expect to evaluate how the creative process may be affected by the input method used. The precise line-tracing task might be representative of multiple tasks ranging from complex linear selections of multiple graphical elements, through solving graphical CAPTCHAs to creative graphics design and free-hand drawing. My preliminary findings are potentially surprising and might be important also in other drawing-like contexts - e.g. in gestural interaction.

Acknowledgements

I thank Mats Lind, Dimitrios Gkouskos, and Sarathkumar Neelakannan for their contributions to this project. This study was partially financed by The Swedish IT-User Centre (NITA) and Anna Maria Lundin Foundation.

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