The Strategies of Text Revision in Virtual Reality Environments

1235064 ZHENG Yilin 【 Human-Engaged Computing Laboratory 】

1 Introduction

The popularity of Virtual Reality (VR) provides the potential of applying daily scenarios into VR environments. In some cases, users need to deal with heavy workload on text editing. Therefore, effective text input methods play a vital role to ensure both quality and satisfaction when users interact in such immersive virtual environments. Text input methods for VR should not only show fast typing speed but also their effectiveness handling various situations, such as typos (and grammar) correction and content rephrasing. Numerous researches focused on improving the typing speed and typo correction with virtual keyboards. However, these studies rarely mention that how users can revise the text in a VR system using a given tool or technology.

We first investigated existing text revision tools used in the current VR typing technology and found two issues: 1) most researchers intend to facilitate typing speed with higher accuracy (typo-free) but with little consideration on how to improve text revision efficiency, and 2) the current text input design based on the VR virtual keyboard does not include caret control; backspace is the only tool that can meet the basic needs of text revision without considering efficiency tools. Facing the founded problems, we 1) provided a design space to explore the possibilities of applying various backspace-caret designs, 2) implemented four VR text revision techniques (as instances of the design space) using virtual keyboards and handheld controllers, and 3) evaluated their text revision performance through a comparative user study.

2 Issues in Current Text Input Methods

To review the current status of VR text input, we did a through analysis on current text input methods, and summarized their attempts to facilitate text revision. By analyzing the results of literature review, we sorted out "design details of VR text input techniques with physical devices" and "design details of VR text input techniques with virtual devices". We found: 1) Numerous researchers have endeavored to eliminate typos and grammar issues by en/decoders, auto-prediction, and auto-completion algorithms. Currently, text input techniques can help users to enter text quickly into computers with few typos and grammar issues. 2) For current VR text input techniques using virtual keyboards, backspace is the only tool to feed the basic needs of text revision (without discussing efficiency and satisfaction). There is a lack of essential considerations about text revision and adjusted solutions in current VR text input designs with virtual keyboards.

To complete text revision, users need to use various tools (e.g., caret and backspace) to insert, delete or substitute words to revise part(s) of the content. Backspace and arrow keys can be easily implemented in the VR scenarios, and the user can use the physical backspace key and arrow keys to transfer their experience to the VR scenarios.

To fill the gap of text revision in the current VR text input designs, we propose a design space for a structural understanding and exploration of VR text revision solutions. Such a design space can help practitioners and researchers propose text input technologies that aim more at practical use in VR scenarios.

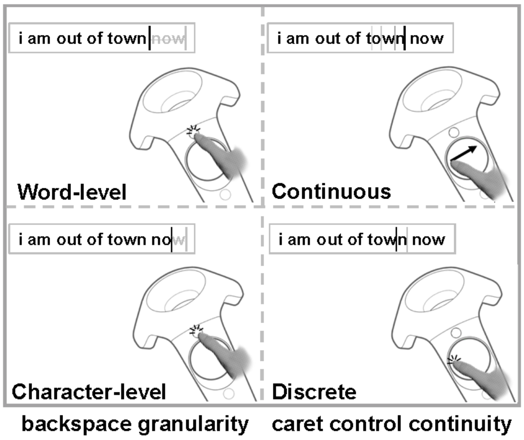

Figure 1: Different options for backspace granularity and caret control continuity.

3 Design Space Exploration

Two parameters that constitute the design space are backspace granularity and caret control continuity (see Figure 1). Each parameter has two values: backspace granularity (character-level or word-level) and caret control continuity (discrete or continuous). In this 2×2 matrix, each combination represents a design solution using various types of backspace and caret control for VR text revision.

4 Experiment

Based on the design space, we propose four VR text revision design combinations of various types of backspace and caret and the techniques that exploit each of them (see Figure 2).

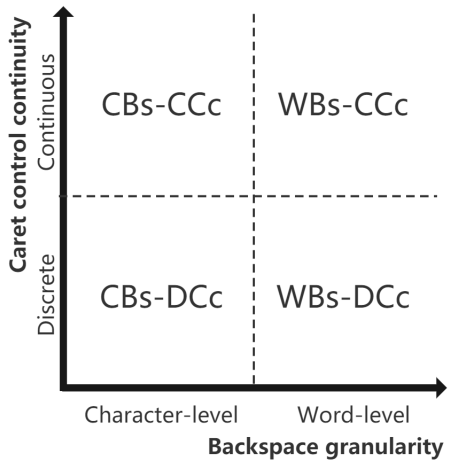

Figure 2: Four text revision techniques and their abbreviations.

The experiment used a within-subjects design to evaluate participants' VR text revision performance using the four proposed techniques. Every participant needed to use each of four text revision techniques to finish 30 sentence revision task. As a result, the total number of revision targets was: 16 participants $\times$ 4 text revision techniques $\times$ 30 sentences per technique = 1920. We mainly investigated and reported the influence of four technique on participants' VR text revision performance. By analyzing the results, we can know the following details:

1) "Operation per character" stands for the average number of operations required to revise one character during the revision. WBs-CCc showed the least number followed with CBs-CCc.

2) "Correction Time" denotes the average duration required to revise the given targets. It is calculated as the interval between the start of a trial and the moment when participants submit the revision. WBs-CCc used the least time while CBs-DCc used the most.

3) "Number of backspace and caret control" count the average number of performing the backspace and caret navigation operation for each revision. WBs-CCc used the least number of backspace while CBs-CCc used the most. For caret control, CBs-CCc used the least number of caret control while CBs-DCc used the most.

4) "Caret control time" stands for the total time spent navigating the caret in each revision. WBs-CCc showed the least caret control time followed with CBs-CCc.

5) "Backspace time" denotes the average total time spent pressing the backspace when revising each target. It is calculated as the total duration between the previous keystroke and the backspace. WBs-CCc showed the least backspace time followed with WBs-DCc.

6) In the paired-scale weighting process of NASA-TLX [1], the top three scales participants scored were Effort (63), Performance (57) and Physical demand (46). WBs-CCc got the lowest weighted scores (lower score means less load to finish the task).

Overall, results showed that WBs-CCc outperformed other proposed techniques with the least operation number per character during revision, the shortest correction time, including the lowest number of operations for caret control and backspace. Participants also regarded that using WBs-CCc can finish the revision with less workload and high usability.

5 Discussion and Conclusion

In this study, first, we reveal the gap in the field of VR text revisions with a comprehensive overview of the current VR text input designs, and provide a design space to better explore the VR text revision designs based on the backspace and caret. We then proposed and evaluate four VR text revision techniques with a comparative study. The results showed the concept of our strategy of VR text revision may also explore novel tools and techniques beyond backspace and caret, or to introduce solutions applied in other platforms (e.g., smartphones).

Text revision is a ubiquitous and vital sub-task during text input activities and practitioners should be aware of the importance of text revision when designing novel VR text input techniques for practical use. Our findings not only provide a basic understanding about how to use backspace and caret for VR text revision, but also provide considerations and suggestions for designing future VR text revision tools and techniques.

References

[1] Sandra G Hart and Lowell E Staveland. "Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research". In: *Advances in psychology.* Vol. 52. Elsevier, 1988, pp. 139–183.