Partial Zoom on Small Display
for People Suffering from Presbyopia

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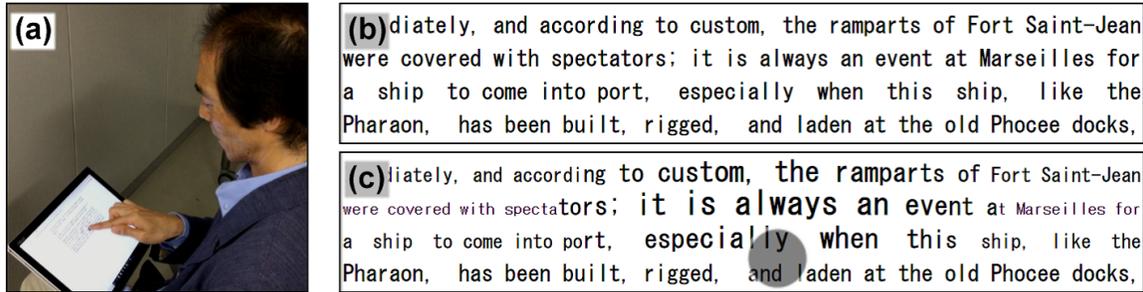
Figure 1: Partial zoom experiment using tablet PC instead of smartphone: (a) Appearance of an experiment, (b) Original size screen, (c) The screen that center is zoomed in partially. A gray circle is a touch position pointer, and the point a little above the pointer is the zooming center.

CCS CONCEPTS

• **Human-centered computing → Human computer interaction (HCI)**.

KEYWORDS

Partial display zoom, Presbyopia, Smartphone

1 INTRODUCTION

When presbyopic people use digital devices, they often zoom in the display, because it is not in focus when they move it close to face. We have proposed the automatic display zoom system for presbyopic people [Fang and Funahashi 2018]. However, some of the information on the small display has gone out of it after zooming-in (Fig. 2(a) to (b)). It is necessary to scroll it frequently, and a bother. On the other hand, a conventional partial zoom means like a magnifying glass is also usually provided (Fig. 2(a) to (c)). The part around a zoomed area is cut off, and it is necessary to move the glass frequently too. People sometimes want to skim through sentences and understand an overview. By the way, although it is

difficult to read blurry words (Fig. 3(a)), you can guess and read a sentence includes the blurry words when some other words are clear (Fig. 3(b)). Therefore, we reconsider the zoom-in method for presbyopic people. For example, the area paid attention is zoomed in to read clearly, and the magnification rate of the area around it is gradually reduced to zoom-out rate so that all information is displayed in the small display even though some words are zoomed out. It is expected that you can guess and read also the unzoomed-in words like blurred words around the clear zoomed-in words. We propose a suitable partial zoom-in function that allows you to skim a document.

(a) Normal (unzoom)   **(b) Usual zoom**   **(c) Magnifying glass zoom**
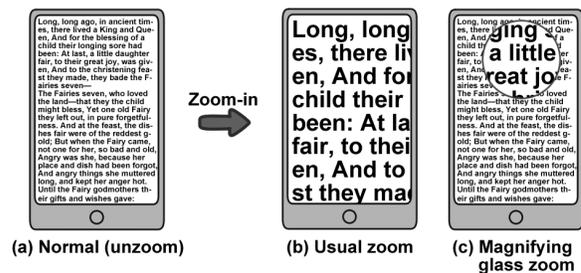
Figure 2: Conventional zoom examples

(a) All words are blurred   **(b) Some words are clear**

Figure 3: Example to guess a meaning of a sentence with blurred words from clear print words

2 REQUIREMENT OF PARTIAL ZOOM

The requirement of our novel partial zoom is that all information of a document is displayed even though some of them are zoomed out. Fig. 4 shows the relation between the position (one dimension) on a display and the magnification rate there. The width of the display is w on a horizontal axis x, the center of the area paid attention is a, and the magnification rate is represented as the vertical axis y. The normal magnification that is unzoom, the usual zoom, and magnifying glass zoom are shown as Fig. 4(a)-(c) respectively. Each area enclosed by the magnification rate line and x axis for the width should be same. Fig. 4(d) shows the outline of our zoom. The magnification rate changes continuously, the value at the area paid attention is larger than 1.0, and it is reduced gradually to the value smaller than 1.0. Of course there is no lack of data.

3 PARTIAL ZOOM OF TEXT AND IMAGE

Here we want to apply our proposed zoom mentioned above to an actual document contains text and image i.e. a PDF file and a web page. However it difficult to decide the two-dimensional magnification curve, we configure a pilot system empirically to evaluate our method. First, we consider text data, it is not necessary that the magnification rate changes continuously exactly, because the deformed letter is not appropriate to read. In order to zoom each letter in the line read and paid attention, magnification rate $R(x)$ for the letter position x is defined as follows,

$$R(x) = \begin{cases} r & (a \le x \le A_1 + a) \\ r - \dfrac{r - 1.0}{A_2}(x - (a + A_1)) & \\ & (A_1 + a < x \le A_1 + A_2 + a) \end{cases} \quad (1)$$

for $x \ge a$ which is the center letter position paid attention, where A_1 is the number of letters required to understand the word itself meaning, and the letters are zoomed in with the fixed maximum rate r. Also, A_2 is the number of additional letters required to guess other words forward of the word paid attention, it means to guess the sentence outline. In our pilot system, parameters are defined as $A_1 = 4$, $A_1 + A_2 = 14$ based on the references [Rayner 1975] [McConkie and Rayner 1975]. And the maximum rate is defined as $r = 1.5$ empirically. The backward area letters are not mentioned in the research, we apply the equation symmetrically
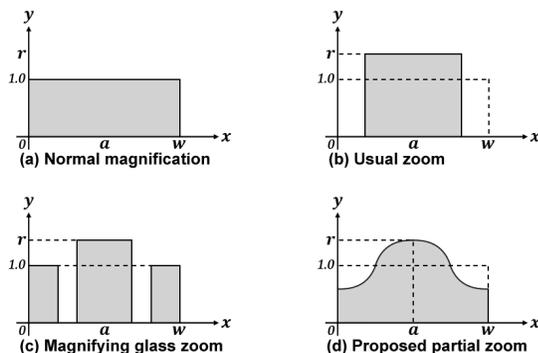
Figure 4: The relation between the position on the display and the magnification for each zoom method
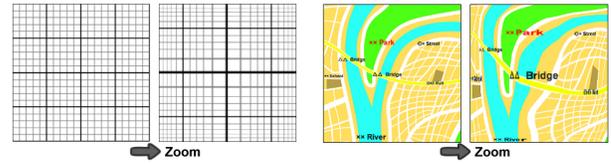
Figure 5: Partial zoom of a grid image

Figure 6: Partial zoom of a map image
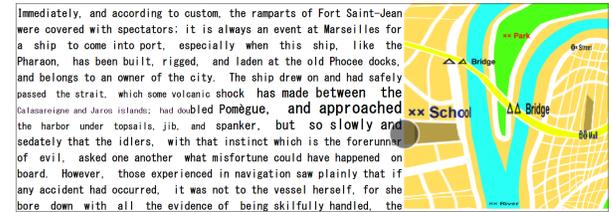
Figure 7: Partial zoom of an integrated document

about the center position. Outside of the zoomed-in area that magnification rate is more than and equal to 1.0, the same rate is applied for the letters there to keep the total length of the line. Although the baseline as the vertical position of each line is kept to keep the total layout, upper and lower lines are also zoomed in by a same way with the rate $r = 1.3$ not to lose sight of the line while swiping the screen. Fig. 1 shows the original size text document and partial zoomed one. Next, we consider image data. Although it is desirable that the aspect ratio at any point is 1.0 locally, square image do not partial-zoomed in to the square. So we apply the empirical one-dimensional magnification curve to both vertical and horizontal direction on an image (Fig. 5). Fig. 6 shows the original size image data and partial zoomed one. Fig. 7 is an example to zoom in the border of an integrated text and image document. In addition, when the area indicated to zoom-in is on the far side, it is handled exceptionally.

4 RESULT AND CONCLUSION

We implement our idea on a tablet PC to develop an experimental system, and presbyopic people try to use it to check how it works (Fig. 1). Since a tablet screen is not too small to zoom in, the display area is limited to smartphone size. The area a subject wants to see more detail is specified by touching on a screen. The center of a screen is zoomed in partially and the surroundings are zoomed out (Fig. 1(c)) from the original screen (Fig. 1(b)) when a subject touches the center. The subjects said that it was easier to read than the usual zoom and the magnifying glass zoom. In the future, the area paid attention should be pointed by an eye tracker. We should also consider asymmetric zoom, because the right area of the words paid attention is more important than the left one.

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