An Evaluation of the iPod Touch as an Alternative Low-Vision Magnifier for People with Low Vision

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Abstract. This study evaluated the feasibility of using the iPod Touch as an alternative low-vision magnifier by comparing its usability issues, subjective ratings, and preferences with those of two existing low-vision magnifiers (SmartView Pocket and Amigo). Thirty participants (30-91 years) performed magnification adjustment tasks and reading tasks using three devices and rated the devices based on ease of use, ease of understanding, and satisfaction. The results show 60% of the participants preferred the pinch zoom gesture and 66% preferred the scrolling one-finger gesture on the iPod Touch. This high user preference data indicate participants' acceptability of finger gestures, which suggests new opportunities for the adoption of new technology for low-vision video magnifiers. The gesture interfaces may be a promising method for magnification and navigation for low-vision users.

Keywords: Low vision video magnifier, gesture.

1 Introduction

In the United States, more than 25 million people have reported experiencing significant low vision [1], resulting in problems recognizing familiar faces, seeing potential hazards such as steps or walls [2], and reading medicine labels, books, and bills, all of which are extremely important for independent living and recreational entertainment [3,4]. To improve reading performance, these individuals use low-vision video magnifiers equipped with a video camera and a zoom lens, allowing a flexible range of magnification [3-5].

Despite the supportive functionality of video magnifiers, low- vision users face challenges when trying to use these devices [6]. To use them, individuals first need to set their desired magnification level and then navigate text by moving the magnifier from one word to the next and from the end of one line to the beginning of the next. Existing low-vision video magnifiers utilize similar types of indirect controls (i.e., require translating physical distance moved by the hand to virtual distance seen on the screen) for magnification. However, studies [7-10] have shown that because indirect inputs require translation between hand movements and visual feedback on a screen,

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they complicate reading tasks, particularly among the elderly, who also commonly have diminished working memory, selective attention, and motor control.

In contrast, studies [7,8,11] have shown that direct controls (e.g., gestures on a touch screen) with no intermediary provide less physical and cognitive demand than indirect controls. Despite the availability of direct gesture controls for magnification and navigation, no studies have directly compared the effects of different controls on the reading performance of people with low vision.

The purpose of this study was to determine the feasibility of using a gesture interface for low-vision magnifiers by people with low vision. The specific aims of this research were to evaluate 1) the usability of two existing handheld video magnifiers and one alternative handheld device as measured by experimenter's observations; 2) subjective ratings of the magnification and navigation of each device as measured by ease of use, ease of understanding, and satisfaction, and 3) preferences of each magnification and navigation method by subjective rank order. We hypothesize that gestural direct magnification and navigation yield higher user satisfaction and user preference than existing indirect interactions for using a low-vision magnifier.

2 Methods

2.1 Participants

Thirty low-vision adults (10 female; 20 male) from the Center for the Visually Impaired (CVI) and Atlanta VA Low Vision Clinic who were prescribed magnifiers for reading participated in the study.

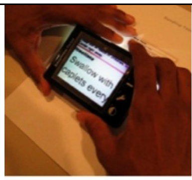
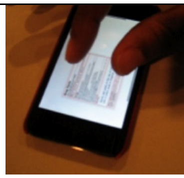
All participants were native English speakers and the age range was 30-91 years, with a mean age of 56.4 ± 18 years. Sixteen (53.3%) participants described themselves as having moderate vision loss (from 20/80 to 20/160), and the remaining fourteen (46.6%) described themselves as having severe vision loss (from 20/200 to 20/400). The participants reported the following diseases: diabetic retinopathy (20%), glaucoma (17%), retinitis pigmentosa (14%), Age-related macular degeneration (10%), arbinism, choroideremia, uveitis, and vitreous degeneration.

Four participants were touch screen users such as iPhone and iPad. However, they said they had any prior experience of using pinch or scrolling navigation gesture on touch screen devices.

2.2 Test Devices

The test devices consisted of two off-the-shelf video magnifiers (SmartView Pocket, Amigo) and one alternative device (iPod Touch). The SmartView Pocket by Humanware has a 3.6" LCD display that provides seven magnification levels from 3x – 9x by pressing increase or decrease (-/+) button. The Amigo by Enhanced Vision has a 6.5" LCD display that provides five magnification levels from 3.5x – 14x by rotating the "Size" knob. To navigate, both magnifiers require the user to physically move the device. In this study, SmartView Pocket was required moving it above the print, and Amigo was slid across the print. The iPod Touch is the 4th generation multi-touch device by Apple with a 3.5” screen size. In this study, iPod Touch was a computer display screen presenting the stored reading materials for the magnification and reading tasks by finger gestures. To control for screen the 6.5” on the LCD display Amigo was masked to reveal a 3.5” display similar to the other two devices. Table 1 shows the characteristics of all test devices.

Table 1. Test devices

	SmartView Pocket	**Amigo**	**iPod Touch**
			
Magnification controls	“Pushing” a button	“Rotating” a knob	“Pinch zoom” gesturing on a touch screen
Navigation controls	Moving device above the print	Sliding a device across the print	“scrolling” navigation gesturing on a touch screen
Screen size	3.5”	3.5” (6.5”)	3.5”

2.3 Tasks

The task was designed to read information from a medicine bottle. The labels included information such as directions. Six different labels that of similar in length (14 ±1 words long) were selected. Three labels were used for the experimental trials, and other 3 were used for training trials. For example, one label included: “Adults and children 4 years of age and older- chew one tablet daily.” All reading tasks were printed on 8.5x11-inch letter size paper for the SmartView Pocket and Amigo devices. The same reading material, but converted pdf files were stored on the iPod Touch. The Bookman app, a PDF reader, was used to open the stored reading material.

2.4 Procedures

Following signing an informed consent form, we asked demographic questions including age, ethnicity, the highest level of education, severity of the visual impairment, their diagnosis, and touch screen experience. After the demonstration of the magnification and navigation functions of all of the devices, participants were trained in use of the devices. Training consisted of increasing or decreasing magnification and reading the text from three of the medicine bottle labels. Training was repeated until participants reported that they felt comfortable using each of the devices.

Test trials consisted of adjusting the magnification and reading tasks using the device. During trials, we observed participants’ interaction with each device and recorded usability issues on magnification task and reading task. The order of labels and devices were randomized to counterbalance the effects of learning. After each trial, we asked participants to respond to a three questions about the ease of use, ease of understanding, and satisfaction on five-point Likert scales. Finally, we asked participants rank order the magnification and navigation methods of the device. The entire test, including training time took approximately one hour per participant.

3 Results

3.1 Observed Usability

We demonstrate usability issues with magnification and reading tasks by participant who used each device.

SmartView Pocket. The participants found the (+) and (–) buttons for the magnification easy to understand and the high contrast of the labels on the buttons (white labels on black buttons) easy to see. However, eleven participants (36.6%) had difficulty positioning the device into focus on the page. In addition, a majority of participants (53.3%) had difficulty stabilizing the device above the page when moving it: Twelve participants expressed negative feedback regarding positioning the device and movement.

Amigo. Eight participants (26.6%) rotated the “mode” knob instead of the “size” knob to adjust the magnification. As shown in Figure 3, the two “mode” and “size” knobs were identical and placed next to each other on one side of the device. In addition, five participants (16.6%) were confused about which direction to rotate (i.e., increase or decrease) the knob for magnification. Four participants (13.3%) had difficulty stabilizing the device while moving it. In general, participants commented on ease of reading while sliding across except for the size and weight of the device.

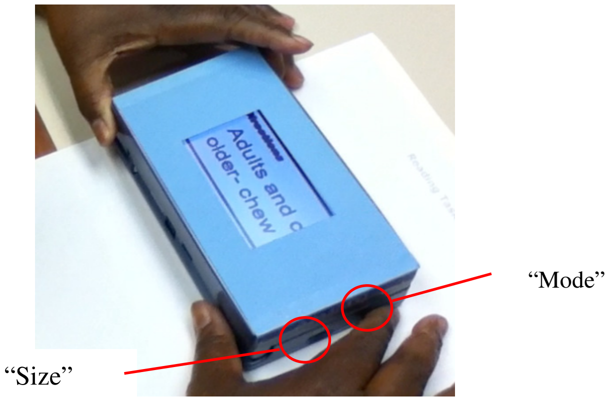


Fig. 1. Participant rotating a “mode” knob instead of a “size” knob

iPod Touch. Two participants (P29 and P30) became confused about spreading two fingers: They moved two fingers simultaneously using their two index fingers instead of spreading two fingers. The participants generally had positive comments about the ease of use, comfort, and preciseness of using the pinch zoom gesture. For example, "The more I use it, the easier it is. It's a simple motion. Very comfortable" (P17). The participants also negatively commented about using the pinch zoom gestures. For example, "It's little awkward and not as comfortable for me" (P23). Two participants (P15 and P24) became confused about which fingers to use: They used two fingers instead of one to scroll while navigating the text. Regarding the use of the scrolling navigation gesture, participants particularly liked its ease of use, simplicity, comfort of using one finger to scroll the page on the screen, reflected in their comments. For example, "Moving the finger around is very good. I don't necessarily have to move the device" (P18).

3.2 Subjective Rating

The mean of the subjective ratings showed no significant difference between the magnification methods with regard to ease of use, ease of understanding, and satisfaction. However, the mean of subjective ratings showed a significant difference between the navigation methods (i.e., moving a device above the print, sliding a device across the print, and scrolling navigation gesture on the screen) on ease of use (p = 0.15), ease of understanding (p= .013), and satisfaction (p = .001). A post hoc paired sample t-test revealed that participants assessed navigation on the iPod Touch significantly easier to use (p = .002) and easier to understand (p = .002) than SmartView Pocket; SmartView Pocket and Amigo showed no difference. In addition, participants assigned the iPod Touch were significantly more satisfied than they were with either SmartView Pocket (p = .001) or Amigo (p = .006).

3.3 User Preferences

Eighteen participants (60%) preferred the pinch zoom gesture, followed by 20% who preferred the button, and 20% who preferred the knob. Participants commented that they preferred the pinch zoom gesture because of ease of use, accuracy, and uniqueness: "The touch feature is easier than the button. It's right there on the display in front of me. You don't have to look for a button or a knob on the side" (P10). "I like the simplicity of the design—no buttons to press, no knob to turn. I like the finger movement" (P16). "The pinch is more accurate than the button" (P12). "It's very unique, different than others" (P06).

Twenty (66.6%) participants preferred scrolling in the one-finger navigation gesture, followed by 23.3% for sliding the device across the print, and 10% for moving the moving the device over the print. Participants commented that they preferred the scrolling navigation gesture because it is comfortable, faster, and modern: "The finger motion is easier. It's so comfortable" (P17). "I like it because I can move my finger faster" (P02). "You can line up with finger easily as you read" (P11). "I see a lot of people use a touch screen; it's more up to date" (P02).

4 Discussion

This study involved low-vision users who evaluated two existing handheld video magnifiers and one alternative handheld device and categorized the major usability issues of existing handheld video magnifiers into magnification control and magnifier movement. For magnification controls using SmartView Pocket, participants clearly understood the + and – buttons. However, using Amigo, they were confused about which direction to move the knob for incrementally adjusting the size of the text because it had no label or indicator for increasing or decreasing magnification; and the dramatic text magnification increments by rotating up instead of down resulted in excessive cognitive demand for participants. A low-vision video magnifier must provide a simple way of controlling magnification.

Another critical feature of the low-vision video magnifier is movement of the magnifier. Using SmartView Pocket, more than half (53.3%) of the participants had difficulty stabilizing the device while moving it. After all, participants had to hold the device at a carefully chosen, controlled distance above the page. These results were similar to those of the optical magnifier that users found it exhausting to navigate text by moving the magnifier from one word to the next and from the end of one line to the beginning of the next [12]. Such a movement poses great challenges, particularly for the elderly, who often have reduced motor control skills [10].

Results of the subjective ratings showed that the direct navigation gesture on the iPod Touch, scrolling using one finger, was significantly easier to use, easier to understand, and more satisfactory than that on either the SmartView Pocket or Amigo, physically moving the device. Participants particularly liked the simplicity and comfort of using the one-finger scrolling gesture. From a practical point of view, one would take a picture of the entire text with the iPod to navigate the picture on a screen. However, we did not include this complex task because the aim of our study was to examine the feasibility of the pinch zoom and scrolling navigation gestures for magnification and navigation by low-vision users.

The results of the preference data were very compelling. More than half of participants (60%) preferred the pinch zoom gesture and found it easier than the button or the knob. Furthermore, once they learned this gesture, it became very easy because they did not need to look for a button or a knob for magnification. These data, which were consistent with those of other research [13], show that gesture inputs using simple multi-finger interaction techniques are more suitable for visually-impaired individuals because they are potentially eyes-free and button-free. A majority of participants (66%) preferred the scrolling one-finger navigation gesture, and they particularly liked the simplicity and comfort of moving their fingers instead of the devices. The ease of use of the finger gesture was predictable since other studies [14,15] indicated that gestures provide a natural interaction, for they are easy to learn and remember. The high preference of gesture-based direct magnification and navigation supports our hypothesis that gestural direct magnification and navigation yield higher user satisfaction and user preference than existing indirect low-vision magnifiers. One limitation of these preference data might have been influenced by confounding variables such as device size, weight, screen resolution, and responsiveness. Nevertheless, our question focused on determining which magnification and navigation methods low-vision users preferred rather than which device they preferred.

According to the participants' comments and performance on the gesture techniques, this study also found the following results interesting. Low-vision participants reported that the finger gesture was "modern and unique" but the button and the knob "old-fashioned"; they thought that the finger gesture was faster and more precise than the other interfaces such as the button and the knob because they felt they had more control over magnification; and while performing the pinch zoom and scrolling navigation gestures, they used various fingers. The choice of any two fingers is another advantage of these gestures.

Based on our findings, additional features could enhance the usability of low-vision magnifiers. During observations on the use of the scrolling navigation gesture, similar to existing magnifiers, participants took more time navigating the text from the end of one line to the beginning of the next. To resolve this problem, we suggest that a digitalized magnified text should be only vertical or horizontal so that users do not have to move a finger a long distance. In addition, providing non-speech audio (e.g., low pitch and high pitch sound) for increasing and decreasing the size of text will also facilitate their setting a desired view of magnification.

The data suggest that because finger gestures for magnification and reading provide ease and comfort, they are preferred by low-vision users. Our findings stress the importance of introducing new technology to assistive technology. In particular, high user preference indicates participants' acceptability of finger gestures, which creates new opportunities for the adoption of new technology for low-vision video magnifiers. The results of this study also show that gestural interfaces represent a promising method for magnification and navigation. Further research should focus on the effects of the long-term use of gesture-based magnification and finger movement.

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