ONLINE EYE-GAZE USABILITY EVALUATION OF GMAIL: ARE MOBILE INTERFACES EASIER TO USE WITH EYE-TRACKERS?

Caroline Wenjia Chen[1], Craig Hennessey[1,2]

HCI Group[1]

Mirametrix Research[2]

INTRODUCTION

Modern-day communications increasingly rely on online interactions using the standard keyboard and mouse interface. However, people living with high-level spinal cord injuries, late-stage ALS, quadriplegia, and other severe disabilities with impaired motor control may not be able to control the keyboard and mouse. Without these control mechanisms many individuals are unable to fully participate in online activities [4].

The last control mechanism in many diseases is the ability to move the eyes. Eye-gaze tracking is therefore a technology well suited to assist this population in computer-related activities [1]. Unfortunately eye-gaze as an interface tool, such as for mouse cursor control, has a number of limitations, including limited accuracy and precision, and may lead to eye fatigue over long periods of use [2].

The goal of this paper is to investigate the potential increase in usability of “mobile” web pages over standard web pages when using eye-gaze as the interface mechanism. Mobile web pages are optimized for small displays and less accurate finger-based interfaces. Interestingly, both these features represent ideal characteristics for gaze-based browsing.

We will compare three different techniques for sending e-mail using Google Gmail. The first technique is the standard keyboard and mouse, the second technique is gaze control on the standard Gmail interface and the third technique is gaze control on the mobile Gmail interface. The evaluation metrics are efficiency (timed speed), accuracy (error rate) and ease of use (qualitative user opinions). We will also suggest possible further improvements to mobile web page designs which may increase their usability for gaze-based interaction.

METHODS

The web page evaluated in this paper was Google Gmail, a popular web based e-mail system. Gmail was chosen for evaluation as it provides both standard and mobile web pages for sending e-mail, and is well known and widely used. An illustration of the mobile Gmail web page is shown in Figure 1, which is optimized for small-screen interfaces such as cell phones and other handheld computer devices [6]. In contrast the standard Gmail web page is shown in Figure 2. Clearly as shown, the mobile Gmail page has a simpler layout, less information, larger fonts and fewer background graphics.

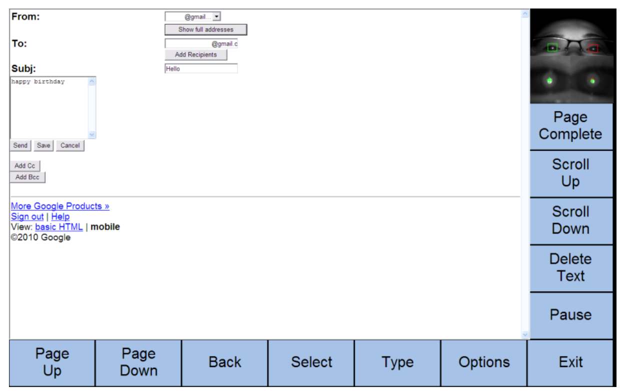

Figure 1: Mobile Gmail web page

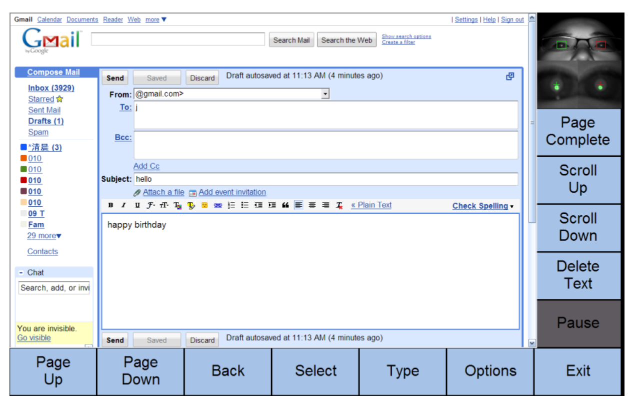

Figure 2: Standard Gmail web page

The standard and mobile Gmail web pages shown in Figure 1 and Figure 2 are rendered in Passport, a gaze-enabled browser. This browser uses standard gaze control features such as gaze controlled cursor positioning, on-screen buttons for mouse functionality such as scrolling, a large onscreen

[1] www.hcigroup.org
[2] www.mirametrix.com

keyboard for text input, and zooming functionality for selecting small links and buttons. Selection or 'clicking' was performed using a dwell time of 1 second. The Passport gaze-enabled browser was used in conjunction with the Mirametrix S1 eye-tracker on a standard laptop computer [5].

Subjects were able bodied individuals who could operate both the standard keyboard and mouse and the gaze-controlled interface. None of the subjects had previous experience with gaze-controlled browsing. Subject ages ranged from 16 to 62 years old, were from a variety of ethnic backgrounds and of both genders.

The following procedure was followed by each subject to complete the usability test:

1. Each subject calibrated the eye-tracker and was then given 10-15 minutes to practice using the eye-tracker with the on-screen keyboard, shown in Figure 3.

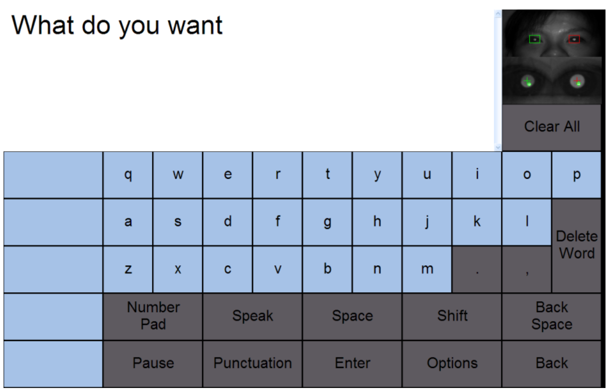

Figure 3: Eye-typing practice with the onscreen keyboard

2. Each subject was then instructed to perform a simple e-mail task in the gaze-enabled browser page by:

   a) Selecting the 'Compose Mail' button
   b) Entering an e-mail address in the 'To' box (the same for all subjects and tests)
   c) Entering the word "hello" in the 'Subject' box
   d) Entering the words "happy birthday" into the content section.
   e) Selecting the 'Send' button.

3. Each subject performed the e-mail task under three different conditions:

   a) Standard Gmail with keyboard and mouse
   b) Standard Gmail with eye-gaze control
   c) Mobile Gmail with eye-gaze control

   The order of these tasks was varied between users to account for potential learning effects. The time to completion was measured from the time the web page first loaded until the time the subject successfully clicked the 'Send' button. The number of errors, defined as selections that missed the intended target, was also recorded for each task.

4. Finally, each subject was given a short survey to provide qualitative feedback on their experience.

A total of 21 subjects were invited to participate in this study, of which 15 completed the tasks outlined above. Reasons for the non-completion of the experiment include the inability to operate the eye-gaze system and the inability of the eye-tracker to correctly track the subject's gaze position.

RESULTS

The average time to completion and standard deviation for each of the e-mail tasks are listed in Table 1 below for the 15 subjects that completed the experiment. The average error rates for each of the e-mail tasks are listed in Table 2 below.

Table 1: Email task time to completion

Task	Mean (s)	Std. Dev.
Gmail with mouse and keyboard	33.73	27.15
Standard Gmail with eye-gaze	422.60	174.70
Mobile Gmail with eye-gaze	232.00	96.33

Table 2: Average error rates

Task	Mean (#)	Std. Dev.
Gmail with mouse and keyboard	0	0
Standard Gmail with eye-gaze	7.93	4.46
Mobile Gmail with eye-gaze	3.33	2.44

A statistical analysis was performed to compare the task time to completion between the three different methods using a one-way repeated measures ANOVA in SPSS. A statistically significant difference was found between the three methods, $F(1.517,21.237)=62.4869$, $p<.005$, with Huynh-Feldt correction, as the assumption of sphericity failed. Post-hoc analysis reveals that the average time to completion for all three methods are statistically different at $p<.005$.

The rate of error or mis-clicks was also analyzed with a one-way repeated measures ANOVA and a statistically significant difference was found between the three methods, $F(2,28)=44.64$, $p<.005$, with sphericity assumed. Post hoc analysis reveals that the average time to completion for all three methods were statistically different at $p<.005$.

DISCUSSION

The keyboard and mouse was the fastest interface with an average task time to completion of only 33.73 seconds. This result was expected as all subjects were familiar with the keyboard and mouse, which are the standard web interface mechanisms. More interestingly, the mobile Gmail with gaze input was significantly faster at average 232.00 seconds than the standard Gmail with gaze input at average 422.60 seconds.

Since mobile web pages are optimized for smaller screens and often used with the lower accuracy of finger inputs, we have shown these types of pages are also better suited for the lower accuracy and precision of eye-gaze input.

The error rate of zero for the keyboard and mouse is not surprising as operation of these input mechanisms is familiar and straightforward. The lower average error rate for mobile Gmail of 3.33 errors compared with the average error rate of 7.93 errors for the standard Gmail page again reflects the improved usability of the mobile page design over the standard page when using eye-gaze as an input mechanism.

In the survey conducted after the completion of the experiment, each subject was asked if they would choose to use the eye-gaze input if they lost the ability to use the keyboard and mouse. Of the 21 subjects (including those who failed to complete the tasks), 17 indicated they would use eye-gaze to e-mail and browse the web if they had no other means available. Of the remaining four, two indicated they would use eye-gaze only for web browsing and not typing, and the other two indicated they would not like to use eye-gaze at all.

The surveys also provided several suggestions for methods to further improve the mobile Gmail web page for use with eye-gaze interfaces. The 'Compose Mail' button was located at the bottom of the mobile page, requiring scrolling to reach, whereas for the standard Gmail page it is at the top. As this button is frequently used it would be better located at the top. The mobile 'Compose Mail' is also a simple HTML link, a larger button would be easier to target. Double line spacing of text and controls would help to target the correct link and reduce miss-clicks. A feedback mechanism, such as a flash, blink, or change of color could help verify when the correct link was selected.

For the eye-tracker, improving the accuracy and tracking ability would help overall performance and ideally enable tracking on all subjects. In the Passport gaze-enabled browser, the onscreen keyboard could be improved by adding shortcuts to common text strings such as "@gmail.com" or "@hotmail.com". An improved mechanism for clearing incorrectly entered data was also mentioned as desirable.

Finally, subjects also indicated that eye-tiredness or fatigue at the end of the evaluation was common, reflecting the unnatural use of the eye as a tool for control. With increased use it is possible that using eye-gaze in this manner will become more natural and thus less of a strain.

CONCLUSIONS

In this paper we compared the standard and mobile versions of the Google Gmail web interface with 15 different subjects. Interestingly, we found that the mobile interface was significantly faster and less error prone to use with eye-gaze as the input mechanism than the standard Gmail interface. The simpler page designs with larger icons and fonts, more distinctive colors and wider spaces between lines lead to improved usability with eye-gaze.

Eye-gaze is not the interface of choice by individuals with alternatives available. For those with no other option, using gaze-controlled browsing on mobile web pages may offer a significantly easier online experience than working with web pages designed for the keyboard and mouse.

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