

Perspective Change: Altering Screen Presentation through Single-sided Eye Closure

ABSTRACT

We present a new viewing modality for on-screen data. We designed, implemented and tested a system that allows users to change the visual presentation of screen contents by closing one eye.

We have studied the principle in three iterations, and tested each of them against the usual, keyboard-based view switching: In one application, our system was rated to be counterproductive, in the second one we found no differences between both, and the third one showed significantly higher ratings for the new modality.

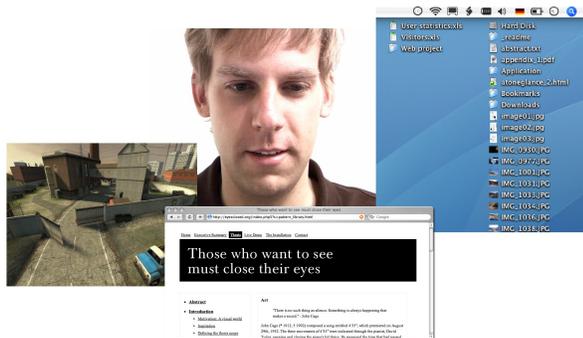


Fig. 1: Normal viewing conditions for SN, ZB and DF (from left to right)

Author Keywords

Eye, eyelid, eye closure, perspective change, prototype, screen interface

ACM Classification Keywords

H5.2 [Information interfaces and presentation]: User Interfaces - Input devices and strategies

INTRODUCTION

Different perspectives on the same data are omnipresent in modern graphical user interfaces.

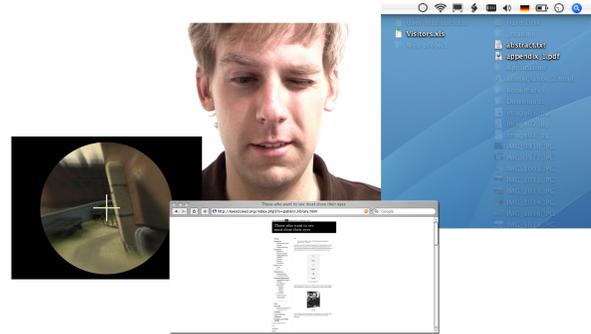


Fig. 2: Alternate perspectives for SN, ZB and DF (from left to right)

Switching between these perspectives is usually acquired through the common means of these interfaces: menus and keyboard shortcuts. We envisioned a novel and intuitive modality for this purpose: Closing one eye.

If we close one eye, especially *not* in front of a screen, what happens is the following: The point of view is shifted sideways by a few centimeters, our field of view is slightly reduced - the things we see are the same, but it feels a bit different, compared what and *how* we saw with both eyes together.

BACKGROUND

The eyelid, or *palpebra* (lat.), serves several purposes: It protects the eyeball (“reflex blink”), it moisturizes its surface (“spontaneous blink”), and it can be shut to prevent light from entering the pupil (“voluntary blink”) [1]. Lid closure is not only caused by muscle contraction, but also by a *passive force*, that results from the construction of the apparatus [8].

Average times for eye closure¹ have been reported to be as little as 88±13ms [12] - with regards to its usage in HCI, short times like these sound promising. However, the participants in [12] closed *both* eyes, and closing only one eye may be slower.

The spontaneous human blink is synchronous - from a computer vision point of view, that makes it easy to distinguish a intended, single-sided eye closure from the occasional blink.

Perspective Changes

Perspective changes - not only those strictly visual - are intellectually pleasing.

One special cultural development that has a special relation to perspective change is what can generally be referred to as *media*. We immerse ourselves in books, films and games, and see can things from a totally different perspective - be it for learning or entertainment. As Johnson [5] argued, modern multi-threaded drama is a sign of a intellectual advancement within our culture.

The ability to handle different perspectives is actually considered as a *sign of intellect*: Imagining a 3D shape by mentally matching different views of it is a common task in modern intelligence tests [3].

In software interfaces, different kinds of perspective change can be distinguished, such as

- *Point-of-view changes*, like the page view in Microsoft Word and the top/front/side perspectives in 3ds max.
- *Data representation changes*, like point, edge, and vertex modes in Cinema 4D, masks and channels in Adobe Photoshop, or infrastructural data blended over satellite images in Google Maps.
- *Tool changes* for manipulation and navigation, as in object/curve editing in Adobe Illustrator, the slide sorting functionality in Microsoft PowerPoint, or the “layout” and “code” views in Adobe Dreamweaver.

Many of these perspectives put the user into their own *mode*, and it has been argued that mode errors are a common problem among computer users - especially, if there is no other feedback channel than the visual [9].

RELATED WORK

Eye-closure has obviously been present as a possible user input in various eye tracking applications [11][13].

¹This refers to voluntarily closing the eye, faster times (53±6ms, according to [12]) have been reported for the reflex blink.

However, using prolonged or double blinks as clicks in these applications has been argued to be a noisy methodology, due to the spontaneous human blink [7].

As recently proposed by Kumar and Winograd [6], simple keystrokes can be used to improve gaze-based user interfaces, and let the actions of hands and eyes successfully augment each other. Ultimately, the eyes are a sensory organ, and not meant to manipulate. The *quasimodal* approach, as proposed by Raskin [9], matches the nature of closing one eye, as we propose it here: Change is present only as long as the muscular action is.

We believed that activating a visual quasimode could offer a natural way of interacting with the mentioned perspective changes, and let hands and eyes cooperate in another new, beneficial way.

EXPERIMENTAL STUDY

We implemented a simple *eyelid tracking* system, using a face finding software [2] and a standard web cam. The face finding software delivered individual data for every eye, and with simple image processing, we were able to determine if a pupil was visible in it or not (Fig. 3). The study was carried out on two computers, one performing the tracking (50fps, at 2.0GHz), and another one, which was running the respective applications. To communicate with the application computer, we enabled the tracking software to generate virtual keyboard events through a Java interface [4] and sent them through a remote control software [10].

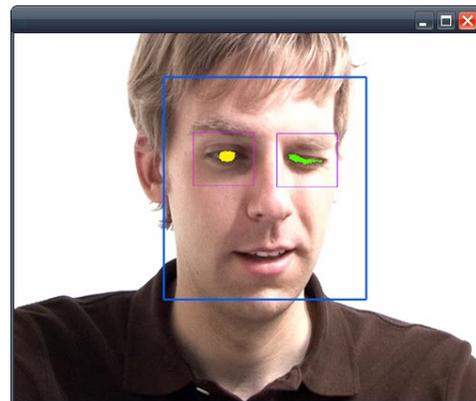


Fig. 3: Face finding software and eyelid tracking

Users and method

A group of volunteer users, aged from 20 to 28 years, was participating in the study. Their experience levels ranged from novice to expert, and they had not been informed about the expected outcomes of the study in advance.

For every experiment, the users were presented a questionnaire in which they were asked to rate two items on semantic differential scales, *bodily ergonomics* on a scale from “exhausting” (-2) to “relaxing” (+2), and *cognitive ergonomics* on a scale from “impairing” (-2) to “helpful” (+2). Both scales offered also a neutral (0) answer.

The results were analyzed in a Mann-Whitney significance test. The users also participated in interviews, in which they were asked open-ended questions about the quality of the interaction.

Prototype: Sniper (SN)

Our initial idea was to use the closed eye to activate the sniper scope in a first-person shooter game. We hypothesized that this feature would allow players to zoom in faster and more intuitively than with a keyboard shortcut.

Users and task

The application was presented to an experimental group of users (3f, 5m, Ø 25.7yrs.), and they were introduced to the fact that when they closed one eye, that would activate the sniper scope in the game (Fig. 1, Fig. 2).

The remainder of the game's controls were at default settings. The control group (3f, 9m, Ø 24.7yrs.) was able to activate the sniper scope through pressing the *shift* key, which is a common key for this functionality in first-person shooter games.

Results

The experimental group showed significant differences to the control group. The eye-based system was rated to be more exhausting than the keyboard-based system ($U = 9,500$; $p = .011$; Fig. 4 (l.)), and also the cognitive ergonomics component of the new interface were rated as less helpful ($U = 11,500$; $p = .018$; Fig. 4 (r.)) than its equivalent in the control group.

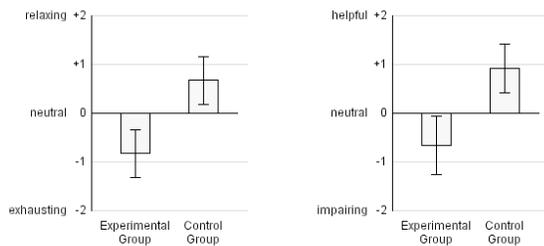


Fig. 4: Subjective bodily (l.) and cognitive (r.) ergonomics for the Sniper (SN) application; both items show significantly lower ratings in the experimental group than in the control group

The user interviews confirmed this. The users stated that the eye-activated sniper feature was “innovative and cool”, but

“very exhausting at the same time”, especially when it was performed either “rapidly, enduringly or in game situations that were stressful themselves”.

Prototype: Zoom Browser (ZB)

Inspired by the implementation of the *Exposé* functionality in Mac OS X, we decided to study another perspective: An overview functionality, for a web browser. In our prototype, a Flash-based simulation, the page could be zoomed out when the user closed an eye (or, in the control group, pressed the space bar) (Fig. 1, Fig. 2). This enabled the user to select a new *target area* using the mouse. When the user returned to normal looking (or resp. released the space bar), the page zoomed into the *target area*.

Users and task

An experimental group (4m, 4f, Ø 25.7yrs.) and a control group (3f, 7m, Ø 24.9yrs.) were introduced to the Zoom Browser and how it was operated. They were, as in the other experiments, given no particular task.

Results

No significant differences were found on either of the cognitive and bodily ergonomics scales, even though a tendency ($.05 < p < .051$) was found for the proposed system to be more exhausting than the keyboard shortcut (Fig. 5).

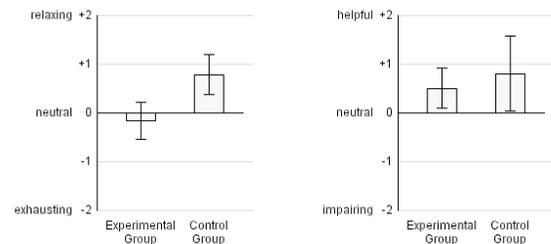


Fig. 5: Subjective bodily (l.) and cognitive (r.) ergonomics for the Zoom Browser (ZB) application; no significant differences on both scales

According to their comments in the interviews, the users liked the functionality. However, also the users in the experimental group asked why this feature couldn't just be controlled “with a simple keystroke”.

Prototype: Desktop Filter (DF)

Both of the preceding prototypes had a strong character of *triggering an event* in the computer. In this final application, we implemented a perspective change that was supposed to generate the impression that the screen's contents *look different when watched with one eye*.

We envisioned a helpful change of the screen's contents, yet subtle, as it should feel natural: One eye would see things a bit different than both eyes together.

In this application, we addressed a common problem and implemented a filter for desktop icons. Preconfigured to *show the last 5 files edited*, users should be able to find what they were recently working on, even on a cluttered desktop, and in short time. We hypothesized that the *one glance is enough* model would be comfortable. Our prototype consisted of a full-screen Flash application, that showed a cluttered Mac OS X desktop. When the filter was activated, all but the 5 most recently edited files were faded out (Fig. 1, Fig. 2).

Users and task

The application was tested with an experimental group (4f, 5m, Ø 25.7yrs.), which could activate the filter by closing one eye, and a control group (3f, 6m, Ø 25.0yrs.), that was able to activate the filter through a keyboard shortcut ("Shift-1").

Results

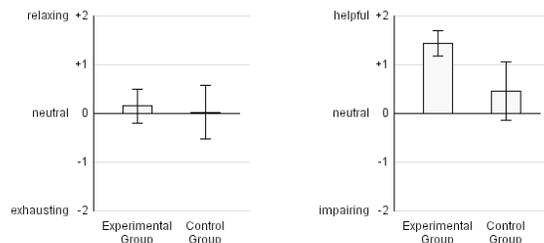


Fig. 6: Subjective bodily (l.) and cognitive (r.) ergonomics for the Desktop Filter (DF) application; significantly higher ratings for cognitive ergonomics in the experimental group, no significant differences between the groups for bodily ergonomics

Opposed to SN and ZB, this application received significantly higher ratings on the cognitive ergonomics scale ($U = 10,000$; $p = .018$; Fig. 6). The user comments in the experimental group confirmed that it was “easy to remember” and “associate the changed view with the eye action”.

DISCUSSION

The quality of the interaction for the proposed system increased from prototype to prototype, which states a good example of iterative design.

Interestingly, the *bodily ergonomics* rating approached “neutral” over time - we did not present the prototypes in random order, so this effect might result from either training or improved interaction design.

In the last prototype, no moving transition between the views occurred on the screen, only a short (about .5s) fading of the icons - we think that this reduced the feeling of *triggering an action*, and facilitated the simple concept of *seeing differently*.

We have discussed that *perspective change* in general is a field of strong potential, and we conclude from our tests that closing one eye, together with good interaction design, can offer great benefits for it.

OUTLOOK

It has to be determined how the proposed principle can be further optimized, and for which other views it is suitable.

It could also be thought of presenting an individual perspective for *each eye*, to allow a broader spectrum of interaction, or to address medical issues like the *lazy eye syndrome* and general eyestrain problems when working at a computer.

Future research on this topic includes thinking about whose understanding of his or her matter could be improved with this system - how an architect, a geologist, or a doctor would work, if he would be able to change perspectives on data so naturally.

REFERENCES

1. Evinger C. Manning KA. Sibony PA., *Eyelid Movements: Mechanisms and Normal Data*, Investigative Ophthalmology and Visual Science, 32, 387-400 (1991)
2. Fröba B. Küblbeck C., *Robust Face Detection at Video Frame Rate Based on Edge Orientation Feature*, FGR 2002, 342-347 (2002)
3. HAWIE-R, *Hamburg-Wechsler-Intelligence Test FE*
4. Sun Microsystems, *Robot*, <http://java.sun.com/j2se/1.4.2/docs/api/java/awt/Robot>
5. Johnson S., *Everything bad is good for you* (2005)
6. Kumar M., Winograd T., *GUIDe: gaze-enhanced UI design*, Proceedings of CHI 2007, 1977-1982 (2007)
7. Lankford C., *Effective Gaze-Input into Windows*, Proceedings of the 2000 symposium on Eye tracking (2000)
8. Meronk F., *Atlas of Eyelid and Facial Anatomy*
9. Raskin, Aza, *Why modes kill*, <http://www.humanized.com/weblog/2006/12/07>
10. RealVNC, *Remote Control Software*
11. Tobii Technology AB, *Tobii Eyetracking System*
12. Van der Werf F. Brassinga P. Reits D. Aramideh M. Ongerboer de Visser B., *Eyelid Movements: Behavioral Studies of Blinking in Humans*, J Neurophysiol, 89, 2784-2796 (2003)
13. Zhai S., *What's in the Eyes for Attentive Interfaces*, Communications of the ACM, 46, 34-39 (2003)