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# Usability Heuristics for Eye-controlled User Interfaces

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Evolution of affordable assistive technologies like eye tracking help people with motor disabilities to access information on the Internet or work on computers. However, eye tracking environments need to be specially built for better usability and accessibility of the content and should not be on interface layouts that are conducive to conventional mouse or touch based interfaces. In this work, we argue the need of the domain specific heuristic checklist for eye-controlled interfaces, which conforms to the usability, design principles and less demanding from cognitive load perspective. It focuses on the need to understand the product in use inside the gaze based environment and then apply the heuristic guidelines to design them. We propose an eight-point questionnaire to validate the usability heuristic guidelines for eye-controlled interfaces.

**Keywords: heuristic, usability, cognitive load, eye tracking, eye movement, user interfaces**

## Introduction

Due to the evolution of low cost eye trackers and its growing impact as assistive technology, several eye-controlled softwares are available that assist people to interact with the application interfaces by eye gaze commands[1] (Porta & Ravelli, 2009; C. Kumar, Menges, Müller, & Staab, 2017). More specifically, eye tracking environment enables people with motor disabilities to communicate with computer applications which is usually limited to only conventional interaction tools like the mouse, keyboard or touch based interfaces.

The design of user interfaces depends highly on the device that is selected as primary input, i.e., the look and feel of interface elements are acclimatized to mouse and keyboard interaction in conventional interfaces. However, when a different physical input device like eye tracker is the primary source, the interface elements needs to be adapted to be more appropriate for that device. In that regard, eye gaze as input is a challenging phenomena due to the limitation of eye trackers like visual angle, calibration errors, drift, and inherent eye jitter. Furthermore, "Midas Touch" is another major problem with eye-controlled interaction since it is difficult to discriminate between inspections and selections (Jacob & Stellmach, 2016). There have been several approaches which deals with these issues by means of gaze signal smoothing, enlarged and customized elements, unambiguous navigation, visual feedback etc. (C. Kumar, Menges, & Staab, 2016; M. Kumar, Winograd, Paepcke, & Klingner, 2007; Majaranta, MacKenzie, Aula, & Räihä, 2006). These approaches do provide relevant methods and discussions for gaze-enhanced design. However the field is continuously evolving and it would be consequential to determine the criterion for relevant assessment of eye-controlled interfaces. Hence, in this position paper we argue the need to establish pertinent usability heuristics for gaze-based user interfaces.

Jakob Nielsen, in his guidelines, laid out ten usability heuristics for interface design (Nielsen & Molich, 1990). This has been widely accepted and adopted to not just web interfaces but also for different environments (Mankoff et al., 2003; Sutcliffe & Gault, 2004; Mi, Cavuoto, Benson, Smith-Jackson, & Nussbaum, 2014; Röcker & Haar, 2006). While Nielsen's work (Nielsen, 1994) forms the backbone of many domain specific heuristic guidelines, it is also important for us to understand stress indicators that come from user interfaces. Prolonged gaze to operate eye-controlled user interfaces lead to fatigue and subsequently wrong selection and high cognitive load. Lupin et al. (Lupien, Maheu, Tu, Fiocco, & Schramek, 2007) stated that increase in cognitive load also happens when experiencing *unpredictability, un-*



[1] http://www.mygaze.com/products/mygaze-assistive

*certainty and unfamiliarity* from the user interfaces (Lupien et al., 2007), thereby evoking a *sense of loss or not having control* (Henry & Grim, 1990) of the navigation that leads to *perception of loss of self-esteem*(Dickerson & Kemeny, 2004).

Moraveji et al.(Moraveji & Soesanto, 2012) focused on the psychophysiology of stress and came out with some points of measure to understand and control them - ability to control interruption, reduction in feeling overwhelmed, use of appropriate tone and emotion, positive feedback to user inputs, acknowledge user actions and demystify user interface.

## Usability Heuristics for Eye-controlled UI

Following the guidelines mentioned by Rusu et al. (Rusu, Roncagliolo, Rusu, & Collazos, 2011) for developing new usability heuristic and closely adhering to Kumar et al. (M. Kumar et al., 2007), Chitty (Chitty, 2013), Hatfield et al. (Hatfield, Jenkins, Jennings, & Calhoun, 1996), a ten-point guideline is described which could provide direction to design and evaluation of eye-controlled user interfaces.

*Design And Aesthetics*:
**#1**: *Visibility* of main interaction elements - for easy accessibility and coherence in eye-controlled interfaces, thus reducing the feeling of uncertainty of accessing the interface to navigate across content.
**#2**: *Aesthetic* design - for comfortable viewing and navigation thus reducing eye strain and cognitive load.
**#3**: *Consistency* of design - to ensure that all icons, typefaces and navigational points are consistent thus leading to lesser confusion and better usability.
**#4**: *Feedback* - to ensure better usability and less error.

*Navigation*:
**#5**: Direct *User-Controls* - provides the user with the ability to control input against inspection. This reduces wrong activation leading to less cognitive load and feeling of being overwhelmed.
**#6**: *Optimized work-flow* ensuring lesser error - leads to quicker task completion. In eye-controlled user interfaces, the lesser the multi-level menus, the better and more precise is the user experience.

*Error and Help*:
**#7**: Optimum *Activation* time - leads to lesser activation of wrong keys due to extremely low dwell times thus minimizing the "Midas Touch" problem, and reducing the sense of frustration and fatigue.
**#8**: Intelligent Design for *Error handling and Recovery* - to handle error in a positive fashion by reducing the feeling of being overwhelmed and by helping recover from the error to the last correct state.
**#9**: Gaze *Accuracy* - to ensure that there is no drift in signal which may lead to activation of wrong keys thus creating confusion and a sense of being overwhelmed.
**#10**: *Graphical* Help and Documentation - leads to quicker understanding of the environment and faster diagnosis than error handling in complete text based documentation.

Subjective assessment of the interfaces is a significant aspect of development cycle, i.e., to validate user satisfaction and substantiate the application. Different application environments often employ System Usability Scale (SUS) (Lewis & Sauro, 2009) or compiles customized questionnaires for this purpose. In the following we describe a questionnaire that closely matches the discussed guidelines for eye-controlled interfaces, along with the SUS measurements, which can help us to asses the aspects of the gaze-based interfaces that can be improved for end-users.
**I)** How comfortable was the size and the position of main interaction elements? (#1 of guidelines)
**II)** How effective was the feedback from interaction element? (#4 of guidelines)
**III)** How aesthetic and consistent was the design and the interaction elements? (#2, #3 of guidelines)
**IV)** How easy was it to navigate from one point to another? (#6 of guidelines)
**V)** How easy was it to interact with the interface? (#5 of guidelines)
**VI)** How comfortable was the selection time of interaction elements? (#7 of guidelines)
**VII)** How efficient was it to handle and recover errors from it? (#8 of guidelines)
**VIII)** How correctly was the system reacting to your gaze position? (#9 of the guidelines)
**IX)** How easy was it to access help if required? (#10 of the guidelines)

Heuristic evaluation based on usability heuristics is quite a prominent method of usability inspection. But generalizing heuristics could lead to missing of domain specific problems. In this paper we discuss some guidelines and an evaluation questionnaire that concerns the design and implementation of eye-controlled user interfaces. The guidelines discussed here follow the balance of generality and specificity. Further development, and evaluation of these guidelines against the conventional guidelines (Nielsen, 2003), for various eye-controlled user interfaces (C. Kumar et al., 2016; Menges, Kumar, Müller, & Sengupta, 2017) is in line for the future work.

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[2] `http://www.mamem.eu`

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