

Conception and development of an accessible application for producing images by gaze interaction - *EyeArt*

André Meyer and Markus Dittmar

Institute for Psychology III
Unit of Engineering Psychology and Cognitive Ergonomics
Dresden University of Technology
Helmholtzstrasse 10
01069 Dresden

Abstract

This paper presents the results of a scientific project of two university students in the field of eye tracking. The aim of this project was to develop an application that can be used both by people with motor impairments and healthy ones. The application enables those with disabilities to draw pictures solely by using their eyes but it can also be controlled by using a connected mouse device.

The first part of this paper will present the basics of controls. Furthermore, the application itself will be explained which includes special text input devices, an approach to navigate through the file system by using nothing else than eye tracking data as well as an explanation of the drawing functions. The last part will be the presentation of the integrated help system which can be used stand-alone by other applications.

1 Introduction

Nowadays, the computer is not only essential for work but also for private life e.g. staying in touch with others or making new friends, online-shopping or getting information about nearly every thing on the internet etc. Thus, it has become one of the most important things for almost everyone. Especially when it comes to new forms of communication the computer can be named. Some years ago, nobody could imagine in how far the introduction and the circulation of computers changed the communication habits of so many people.

Today, one of the most common form of distant communication is email conversation. Even the synchronous means of communication like the telephone are already being replaced by using the internet; for instance the so called "Voice over IP" (VoIP) which is getting more and more important. Communication itself had and always will have a great impact on social interaction. Therefore, it is necessary to enable people with motor impairments to communicate with every person they want to and to furthermore offer the

biggest variety of communication types. This includes email contact as well as chatting and, when possible, speaking via VoIP.

However, it is also necessary to integrate communication forms that are really underestimated. Already the Stone Age people communicated with the help of drawings. Knowledge and experience were passed from generation to generation by using cave paintings. Young children use pictures to express their feelings, thoughts and emotions. Even when growing old most people like to paint because it can be both relaxing and challenging.

Summing up these facts, we decided to provide those people with impairments an application which would finally enable them to express their thoughts and feelings by drawing pictures by merely using their eyes. Although there already is an existing project in the network of intelligence of COGAIN, called Eye-draw, we were not even able to start this program, due to an eye tracking device incompatibility.

Furthermore, some screenshots and the intensive studies of the source code let us come to the conclusion that some essential parts of a drawing program were missing. Therefore, we decided to develop an application that could either be controlled solely by eye tracking devices or by mouse and which would provide as much tools for drawing operations as possible.

2 Controls

When using a special eye tracking device it is not guaranteed that the application will work on other systems

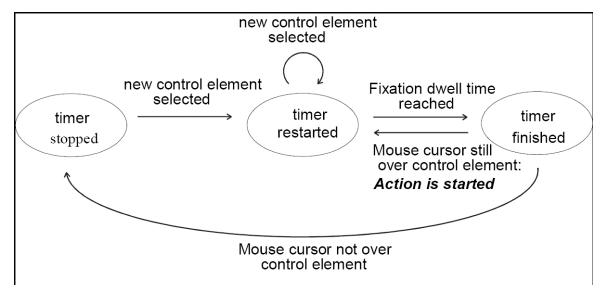


Figure 1: The fixation process and the timer

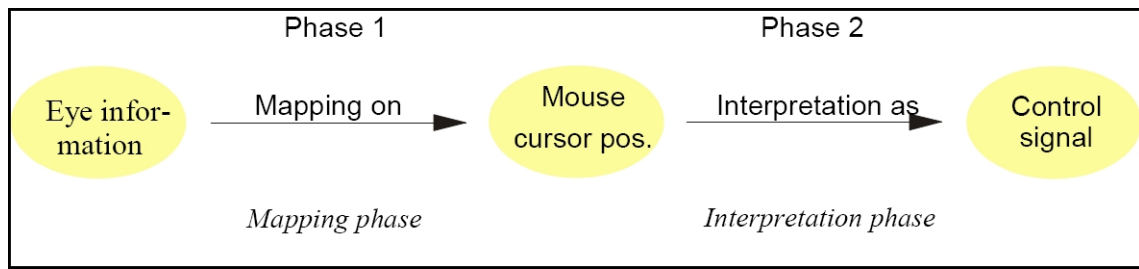


Figure 2: The two phase progress of gathering information about eye movement

with another device as well. Since the aim is to widely spread the program *EyeArt*, we decided to develop another concept of controlling. We developed a library consisting of both programming elements and control devices that can either be used by eye tracking devices or by mouse or both. The system is simple but effective. Each eye tracking system provides a lot of additional software and in most cases there is a special one to control the mouse movements. As can be seen in figure 2, the mouse cursor is the referencing point; all actions are performed with the help of the mouse.

The only possibility to use the mouse as an eye controlled device is by focussing a spot with one's eyes for a certain length of time. One could argue that this might also be possible by using saccades or blinks but saccades are an arbitrary movement of the eyes and cannot be controlled. Furthermore, the movement of a saccade is always a convex movement but a straight line cannot be followed. It is also impossible to use blinks. Using this type of controlling requires the execution of controlled blinks but most blinks are arbitrary. Thus, the usage of this type of controlling would not provide clear instructions. It is also a very weakening and hard procedure.

As both, saccades and blinks, are not suitable for controlling an eye controlled drawing program, the only possibility is to use the above-mentioned focussing of the eyes. If the mouse cursor enters a context sensitive element of the application, a timer is activated. To control the timer there are two dwell times, the application dwell time and the application warn time. The application dwell time is the overall time one must focus on a spot before an action is triggered. The warn time indicates that a focussing-process is in progress and an action will be triggered shortly. This time is integrated within the dwell time. The total process can be seen in figure 1 on page 1.

If the timer process finishes successfully, the applied action of the control element is executed. All controlling functions and control elements are integrated in one library and can be reused by using the library in other applications.

3 Main program

The main program, *EyeArt*, consists of three different parts. These are the drawing grid, the main menu and the tool box. The drawing grid consists of two parts, the grid itself and a status bar on the bottom, as can be seen in figure 3 on page 3.

The main menu is located on the top of the application window. The main menu is shown in figure 4 on page 3 consists of the following functions:

- New - to start with a new drawing
- Open - to load existing pictures
- Save - to store the momentarily presented picture with the default or momentarily used name and path
- Save as... - to store the momentarily presented picture with a new name and path
- Print - to print the picture on the momentarily selected default printer device
- Undo - to undo potentially wrong or failed drawing operations
- Options - to enter the options menu
- Help - to start the *EyeHelp* program
- Exit - to exit the application
- Cancel menu - to cancel the main menu and return to the application

The toolbox is located on the left hand side of the main application window in the area marked with the word "Tools". It can be activated by focussing this area with ones eyes for a certain length of time. The toolbox is shown in figure 5 on page 4 and contains the following tools:

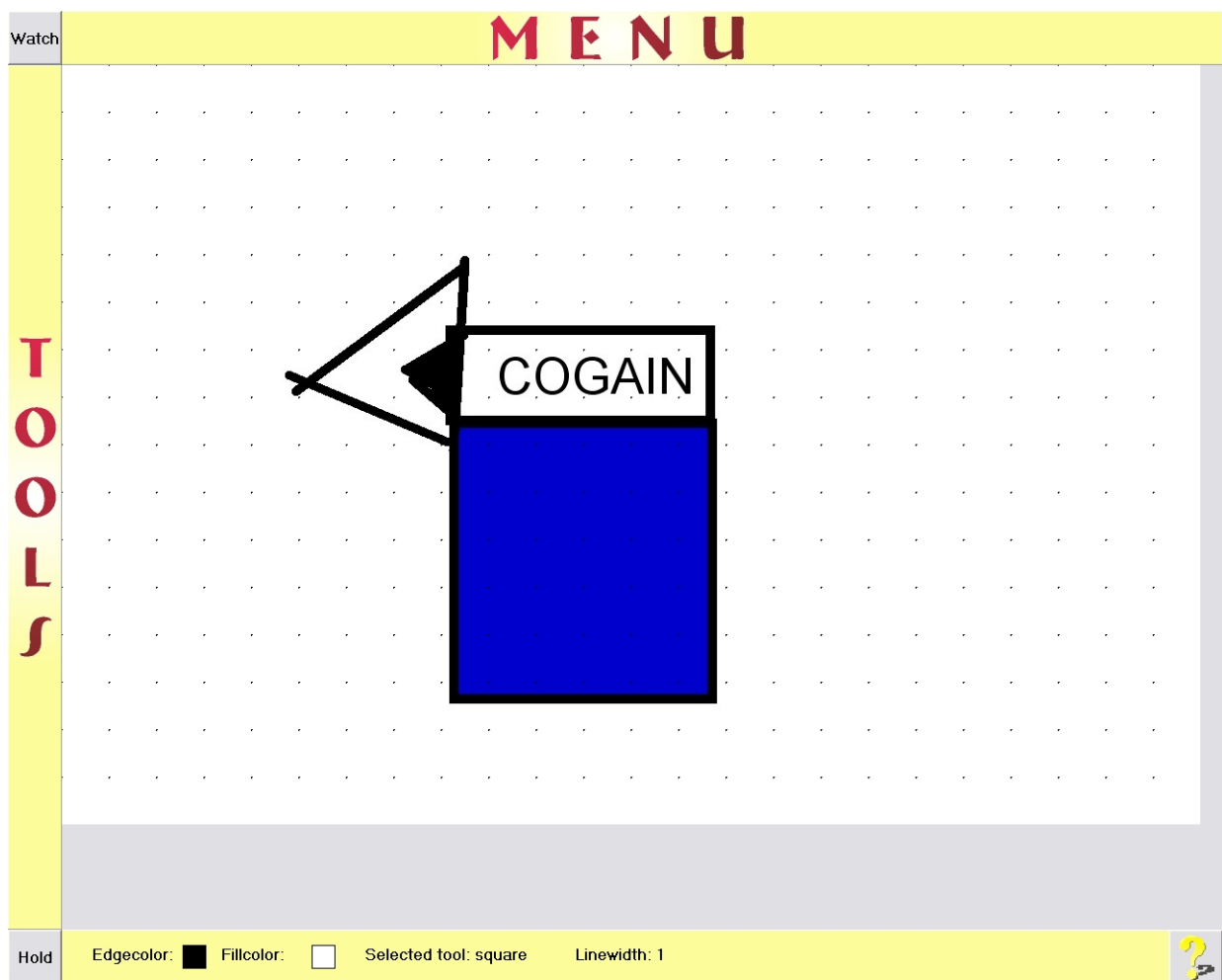


Figure 3: The main application *EyeArt* with the grid for better orientation



Figure 4: The menu bar of *EyeArt*

- Watch mode tool - to activate the watch mode
- Circle tool - to draw circles
- Ellipse tool - to draw ellipses
- Line tool - to draw lines
- Poly line tool - to draw poly lines
- Square tool - to draw squares
- Rectangle tool - to draw rectangles
- Text tool - to insert text by using a virtual keyboard and a stamping function
- Polygon tool - to draw polygons
- Rubber tool - to erase specific parts of the drawing
- Flood fill tool - to fill shapes with the selected background colour
- Pencil strength tool - to select the strength of the used pencil
- Pipette tools for fore and background - selecting a colour in the drawing
- Colour selection tools for fore and background - to select the colour for the fore and background from a colour grid



Figure 5: The toolbox of *EyeArt*

To open or save a file we designed special dialogs that represent the hierarchy of the file system and enable the user to navigate through it. This can either be done by using an eye tracking device or by mouse. The dialogs can also be reused in other applications but have to be adapted to the new content. One tool of the Toolbox is the virtual keyboard. This is a special dialog for entering words or phrases by using ones eyes. Its design is oriented on the normal keyboard layout and it contains nearly the same functions. Only a few signs were removed. Figure 6 shows the layout.

To enter text it is necessary to focus on the corresponding button with ones eyes. A visual reply will show the success of the proceedings.

Because of the limited scale of our project we had no opportunity for studies on the usability of *EyeArt* in the field of people with motor impairments. Thus, we only tested the software in our laboratory to get feedback on the usability and potential improvements.

The first thing we found out is that it is very hard to focus on a blank screen. If the user started drawing in a newly opened document there would be nothing to focus on because the new image had a uniform background. Therefore, we integrated a grid to offer better orientation and control. It is visible when the program is waiting for input of points to draw and hidden if the drawing operation is finished.

We also learned from the test that it might be useful and convenient to decide if the selected drawing tool will be reselected after its operation or not. If a tool is selected the user is forced to set the points needed to draw the linked object. So he can draw objects in sequence without having to manually reselect the same tool. Otherwise, the user could also draw an object and pause without having to deselect the tool.

From the very beginning of the *EyeArt*-project we have had the idea of two acting modes. The first one is the "working mode" in which the user can do everything the program is made for. If the user focuses on a context sensitive element on the screen for the length of the dwell time an action will be performed. To reduce stress there is a second mode called "watch-

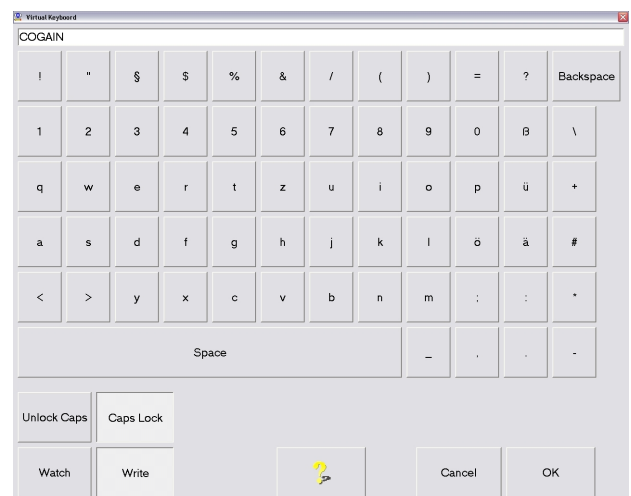


Figure 6: The virtual keyboard

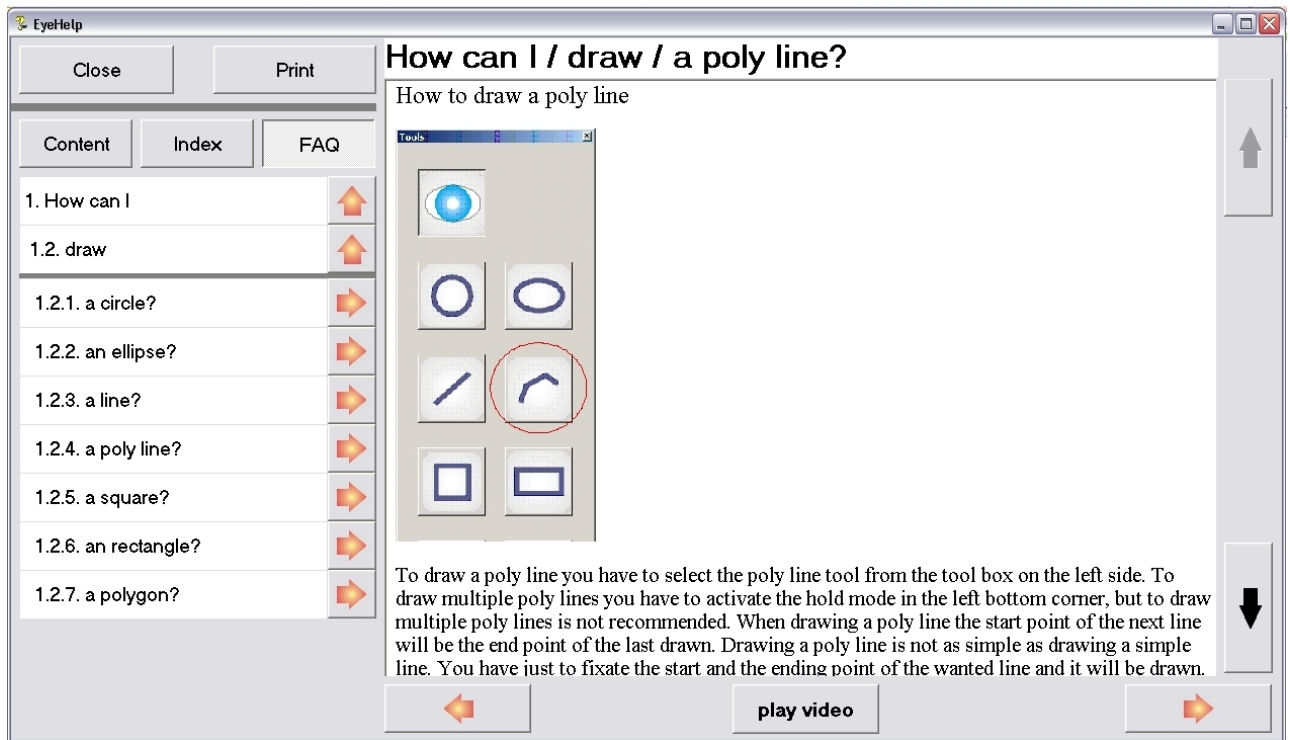


Figure 7: The application *EyeHelp*, in opened at FAQ

mode”. In this mode all controls are deactivated except a button to go back to the working mode. So the user has enough time to take a break or to have a look at the control elements shown on the screen and to get familiar with them. This two-mode concept is realized in all parts of the software and very important especially for new users.

4 *EyeHelp*

The last part of the project is the help system called *EyeHelp*. This is a stand-alone application with a modular structure. Every kind of other software can use this system. The only thing to do is to create the own content in rtf-files and a special content file that is read in at program start and contains the content layout. It is possible to arrange the content in a hierarchical manner like in other help systems.

There is also a query by keyword function and a special FAQ section based on the menu-based natural-language input system. The program with empty fields can be seen in figure 7.

Besides the three help categories there is the possibility to print the text shown. It is also possible to play a video via the integrated video player. If there is a video with the same name as a help text, a button appears and the user can start a video which will then demonstrate the explained process in a dynamic way. This is a feature which could prove useful because the user might get exhausted by just looking on the screen, doing nothing but reading text.

5 Future

The applications *EyeArt* and *EyeHelp* can be used in many common contexts. *EyeArt* itself is an improvement of the existing project Eyedraw and provides new functioning and better usability than any other eye drawing program. The integrated dialogs can be used in other applications via documented interfaces.

The program *EyeHelp* is a stand-alone help system that can be used by anyone who wants to place help at his/her user’s proposal. Improvements can be made by using vector based graphic instead of pixel based graphic and by integrating more functions that come along with the change in graphics like scaling tools, moving tools or deleting tools.