Chapter 1

Introduction to Gaze Interaction

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ABSTRACT

Gaze interaction, as understood in this book, provides a means to exploit information from eye gaze behaviour during human-technology interaction. Gaze can either be used as an explicit control method that enables the user to point at and select items, or information from the user’s natural gaze behaviour can be exploited subtly in the background as an additional input channel without interfering with normal viewing. This chapter provides a brief introduction to the potential for applied gaze tracking, with special emphasis on its application in assistive technology. It introduces common terms and offers a concise summary of previous research and applications of eye tracking.

INTRODUCTION

Eye tracking systems are used to monitor eye movement and to translate the user’s gaze direction into, for example, computer screen coordinates. For people with severe motor disabilities, gaze may be their only means of operating a computer, communicating, writing emails, playing games, or controlling their environment (Donegan et al., 2009). For them, gaze replaces the computer mouse and keyboard as the input method (Scott, 2010). At the other end of the potential user scale, anyone can benefit from eye-aware applications that adapt their behaviour based on the user’s visual attention. If an application is aware of the user’s current attentive state or where their visual attention is targeted, it can “know” more about the user’s interests and intentions and accordingly react in a more natural way (Jacob, 1991).

This chapter provides a concise summary of previous research and an overview of the potential for applied gaze tracking, which is explored in more detail in the thematic sections of this book. Below, we will first have a quick glance into the history and applications of eye tracking, followed by a brief introduction to currently
available gaze-based assistive devices. We close by introducing some common terms that recur throughout the book.

**BRIEF HISTORY AND BACKGROUND OF MODERN GAZE TRACKING**

Early eye tracking systems were used for studying the nature of human eye movements rather than for interaction. First studies on human eye movement were made by direct observation (see Wade & Tatler, 2005, for an extensive review of the history of eye movement research). The early devices were often invasive and uncomfortable as they required the user to wear special instruments or their head position to be fixed by using, for example, a bite bar. The highly cited pioneering work by Yarbus (originally published in 1956 in Russian, reprinted in English in 1967) was conducted using a device with a ‘cap’ that was “attached by suction to the eyeball”. This ‘suction device’ required that “the cornea is anesthetized, the lids taped apart, and the subject trained to inhibit the natural tendency to move the eyes” as a precaution to prevent injury on the eye or the device (Yarbus, 1967: quotes taken from the Foreword). A number of experiments on characteristics of eye movements and visual perception were carried out using this device.

The first “non-invasive” eye tracking apparatus, based on photography and light reflected from the cornea, was developed by Dodge and Cline in the early 1900s (Wade & Tatler, 2005). This “Dodge Photochronograph” inspired many later eye tracking devices and is considered the primary ancestor of the current video-based corneal reflection eye tracking systems. The device, and later improved versions of it, were used to categorize numerous basic eye movement properties and types, and laid the foundation for modern eye movement research. Over the years, major effort has been invested into the development of eye tracking technology and more accurate gaze estimation methods (see, e.g., Young & Sheena, 1975; Duchowski, 2003; Li, Babcock, & Parkhurst, 2006; Hansen & Ji, 2010). As a result, usability of modern eye trackers has vastly improved since these early days of eye movement tracking (for examples, see Figures 1 and 2).

*Figure 1. Some of the earlier devices required manual adjustment of the analogue video via a separate control unit (on the left; © 1999 TAUCHI. Used with permission). Today, the digital video image can be analyzed in real time through an all-in-one system that includes a laptop, screen and video camera embedded in a single portable unit (on the right; © 2007 COGAIN. Used with permission).*
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