Chapter 24
Discussion and Future Directions for Eye Tracker Development

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ABSTRACT

Eye and gaze tracking have a long history but there is still plenty of room for further development. In this concluding chapter for Section 6, we consider future perspectives for the development of eye and gaze tracking.

DISCUSSION

Eye and gaze tracking have a long history, but it is only relatively recently that gaze trackers have become sufficiently robust for use outside laboratories (Hansen & Ji, 2010). This development, alongside the ongoing reduction in price and increase in number of manufacturers, opens up many more application domains.

In the previous chapters of this Section 6, we have provided a guided tour through various aspects of eye tracker development and have described the basic hardware equipment and how it is used in eye trackers. Proceeding from this, we provide a gentle introduction to how eye images can be processed in order to obtain relevant feature parameters, such as the iris and pupil ellipses and glint locations. Through the feature descriptors it is possible to estimate the gaze direction, and

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hence the gaze location of the user. The different approaches to determining gaze in both calibrated and uncalibrated set-ups, as well as in both remote and head-mounted eye trackers are outlined. These methods are fundamentally different, and there seems to be room for improvement along several dimensions, to improve both eye detection and gaze estimation methods. For example, few systems have managed to cope well with reflections from eyeglasses.

The previous chapters have described the important role played by infra red (IR) light in current eye trackers and the special properties that make IR light particularly suitable for illuminating the eye. As with any light source, user safety must be carefully considered in terms of the effect on eye structures. The foregoing discussion concluded with a thorough explanation of hardware issues and safety considerations.

FUTURE PERSPECTIVES

In the following discussion, we consider future perspectives for eye and gaze tracking. The precision of current gaze trackers is sufficient for many types of applications. Both accuracy and having few calibration points are desirable properties, but they are not necessarily the only parameters to be addressed in a gaze tracker (Scott & Findlay, 1993). Price is obviously an issue, but it is one that may be resolved through current technological developments. In some situations, however, it would be convenient if light sources, cameras, and monitors could be positioned according to particular needs rather than being constrained by manufacturer specifications (Hansen, San Agustin, & Villanueva, 2010). It seems likely that the high accuracy required to measure eye movement parameters beyond simple fixation position would not be possible without fixed hardware geometries; however, many applications do not require exact measurement of further parameters of eye movements. If eye trackers can also function reliably in both indoor and outdoor scenarios, they are likely to become more widespread and diverse in their application. Current and future topics for eye and gaze tracker hardware development include the following, outlined by Hansen and Ji (2010).

Illuminating the Eye

IR light is useful for eye trackers, mainly because it is not visible to the user but also because it can be used for controlling light conditions, obtaining higher-contrast eye images, and stabilising gaze estimation. A practical limitation of systems using IR light is that they are not necessarily reliable when used outdoors, although pulsing the light or alternating between on- and off-axis lighting can eliminate many aspects of the problems associated with erroneous light sources. However, tracking outdoors is problematic regardless of the type of light used to illuminate the eye. There is room for improvement and methods that can provide more robust detection of relevant features.

Head-Mounted Systems

While significant emphasis has been placed on remote gaze tracking, head-mounted gaze trackers could be applied to interactive scenarios in the future, because of both the challenges facing remote eye trackers and the increased interest in mobile eye tracking and tiny head-mounted displays. For future technologies, head trackers may also offer a means of tracking several users while they look at the same screen, whereas remote eye trackers imply one user per screen.

Flexible Hardware Set-Up

Many current gaze trackers require calibration of the camera(s) and the geometric arrangement. This is a quite well understood domain theoretically (Guestrin & Eizenman, 2006). A significant limitation of fully calibrated set-ups is that they require precise knowledge of the rela-