A binocular evaluation of pupil-size dependent deviation in measured gaze position


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Introduction

Camera-based eye trackers are the mainstay of eye movement research and countless practical applications of eye tracking. Recently, a significant impact of changes in pupil size on gaze position as measured by camera-based eye trackers has been demonstrated (Wyatt 2010), and a first attempt at compensating for this drift was proposed (Drewes et. al. 2012). While ground truth was presented in Drewes et al., all previous studies used very few subjects to demonstrate this effect (5 and 2 respectively), and only monocular measurements were performed.

To improve understanding of the magnitude and population-wise distribution of the pupil-size dependent shift in reported gaze position, we present the first collection of binocular pupil drift measurements recorded from 20 subjects. Subjects were students at Yunnan University. Eye movement data was recorded binocularly using an SR Research EyeLink 1000. Pupil size changes were induced by changing the background luminance of the screen. Gaze measurements were calibrated on 5x5 point grids with 5 degree spacing, using several background luminance levels. We evaluate 3 different approaches to compensate for the pupil-size induced drift.

Methods

Paradigm

Calibration at constant luminance levels

Drift measurement at variable luminance

Results

Raw Data

Subjects were asked to fixate steadily, while background luminance changed

Drift Direction Distribution

Mean drift amplitude: 2.4 degree (0.8 – 4.3)

Residual Error per Time-Interval

Average Residual Error:

2-Point: 43%
3-Point: 40%
LUT: 28%

Conclusions

The absolute pupil-size dependent drift varied greatly between subjects (0.8 to 4.3 degree, mean 2.4 degree), but also between the eyes of individual subjects (0.16 to 1.7 degree difference). The preferred drift direction was inwards and down, in direction of pupil constriction. Our compensation method optimized in direction of constriction reduced drift by 72% (avg).