An Eye for an Eye: A Performance Evaluation Comparison of the *LC Technologies* and *Tobii* Eye Trackers

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Eye-tracking systems have been employed in many diverse fields, including psychology, cognitive science, disability rehabilitation research, and human-computer-interaction (HCI). Although numerous studies have been conducted involving applications of eye tracking, few studies have compared the actual eye-tracking systems themselves. We empirically evaluated the system characteristics of two independent eye-tracking products using the following parameters: *accuracy*, *reliability*, *robustness*, *ease of setup*, *ease of development, API capabilities*, and *real-time performance* as metrics. As well, we qualitatively evaluated the various analytical software tools and features provided by each eye-tracker.

We evaluated the following two systems: *LC Technologies Inc.* Eyegaze, and the *Tobii Technology* ET-17. Both systems utilize a similar passive, near-infrared detection method; however, they use different implementation schemes. Due to the differences in their approaches, the purpose of this evaluation was not to strictly determine which system was superior in performance, but rather to illustrate the various strengths and weaknesses of each system using a set of quantifiable criteria.

Evaluation of the *Tobii* ET-17 was conducted on a *Dell* 8250 with a 2.6 GHz *Intel* Pentium 4 processor and 512 MB DDR memory. Evaluation of the *LC* Eyegaze was conducted on a *Matrox* Insight with a 350 MHz *Intel* Celeron processor and 128 MB SDRAM memory. This was the original system provided by *LC Technologies*. Other hardware was optimized to fulfill the minimum hardware requirements of each system. The large disparity in processing power between the two eye trackers was justified upon further consultation with the manufacturers; the image processing code utilized by the *LC* Eyegaze has been tuned in-house by *LC Technologies* to perform optimally with minimal CPU consumption.

The subject pool consisted of ten users of mixed sex, ethnicity, physical characteristics, and visual acuity. Subjects requiring the aid of eyeglasses or contact lenses were asked to remove them prior to testing. The pool consisted of subjects with prior experience with eye trackers as well as novice users. Ambient lighting and external infrared sources were controlled to maintain an evaluation environment similar to a conventional commercial office setting. To reduce erroneous measurements due to saccades, a fixation of 200 ms at each test point was required before data logging commenced.

Summary – Results show that each eye tracker excels in different areas, however, neither system was clearly globally better than the other. Overall, the *Tobii* ET-17 performed marginally better than the *LC* Eyegaze in terms of accuracy, reliability, and robustness.

Evaluation Category	Significance (2-tailed)	*Tobii* ET-17	*LC* Eyegaze
Accuracy – Euclidean distance between the observed point of gaze and the actual position of the respective test point (in pixels)	$p > 0.4$	18.6	21.5
Reliability – % of dropped samples for a given evaluation with *n* sampled values	$p < 0.03$	0.4%	2.2%
Robustness – Calibration persistence (rate of performance degradation from extended use without calibration)	$p < 0.02$	22.0 (Accuracy) 0.65% (Reliability)	28.2 (Accuracy) 2.9% (Reliability)

Tobii ET-17 – The binocular design and large field-of-view of the *Tobii* ET-17 affords greater tolerance to head movement and provides a larger operational workspace – approximately 20x15x15 cm (horizontal x vertical x depth). Its higher level of robustness translates into more persistent user calibrations.

LC Eyegaze – The zoom lens on the *LC* Eyegaze provides a higher resolution image of the eye. This enables it to accurately detect pupils with a higher degree of pigmentation. Coupled with droopy eyelid compensation, this enables the *LC* Eyegaze to operate correctly with a wider cross section of subjects. Support is also provided for users with glasses and contact lenses. The low processor overhead allows the *LC* Eyegaze to operate on less powerful machines without sacrificing performance. This allows it to be both compact and portable.

Conclusions – For applications involving a high tolerance to head movement use of the *Tobii* ET-17 is more appropriate, while applications with a diverse pool of subjects would benefit from the higher tolerance to ptosis (drooping eyelids) and glasses of the *LC* Eyegaze. New models of both the *LC* Eyegaze and *Tobii* ET-17 are being released, promising new features and improved overall performance. Of particular interest is the new binocular implementation of *LC*'s eye tracker which will feature improved tolerance to head motion and ambient light. This may address the robustness differences between the *LC Technologies* and *Tobii Technology* products.