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Exploring the Possibilities and Limitations of Webcam-Based Eye-Tracking for Interactive and Static Map Studies: A Comparative Perspective on WebGazer and RealEye

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Abstract:

Webcam-based eye-tracking has gained attention as a cost-effective and accessible alternative to traditional laboratory setups (Yang & Krajbich, 2020), presenting new opportunities for map-based user studies (Fairbairn & Hepburn, 2023). In this research, we have designed and run two map user experiments with webcam-based eye-tracking: one with static maps using the open-source tool WebGazer (Papoutsaki et al., 2016) (in conjunction with the CartoGAZE[1] stimuli) and one with interactive maps using the commercial RealEye platform (Realeye.io, 2025) (under an educational license). We examine key dimensions such as accessibility (open-source vs. commercial), experimental design capabilities (static vs. interactive), ease of use, data quality, calibration/gaze estimation accuracy, raw data export, and additional metrics like logging mouse and keyboard activities.

A critical comparison of these two approaches highlights the design challenges and data reliability across static and interactive map-reading tasks. Preliminary findings indicate notable differences, e.g. in user calibration or data precision. For instance, in the case of WebGazer, approximately 31.43% of participants achieved the calibration accuracy threshold of 80%. However, even among those who passed the threshold, poor data quality is observed, likely due to participant movement or variations in environmental factors. This underscores the inherent challenges of uncontrolled remote setups and webcam-based methodologies. Interactive tasks introduced further complexities, revealing trade-offs in accuracy, usability, and experimental design specific to each tool. A summary comparison table illustrates the strengths and limitations of both platforms (see Table 1), offering practical insights for researchers choosing between open-source and commercial solutions in diverse cartographic contexts.

The choice between WebGazer and RealEye depends mainly on the technical expertise of the team, project requirements, and the intended use case. WebGazer is ideal for developers or researchers who prioritise flexibility and have the programming skills necessary for custom integrations. This tool is particularly suited for static map experiments and offers the advantage of being open-source with no licensing fees, though it requires careful implementation to ensure data accuracy. Conversely, RealEye caters to users seeking a quick, user-friendly solution for static map (or potentially interactive) experiments, benefiting from built-in calibration and reliable data quality with fewer exclusions. However, it comes with a subscription cost and less flexibility in customisation. Both tools emphasize the importance of calibration and participant environment factors, such as lighting and webcam quality, to achieve optimal gaze estimation accuracy. Regarding participant recruitment and data handling, RealEye simplifies the process through integrated tools and customer support, while WebGazer relies on external methods and community forums for troubleshooting. Researchers planning eye-tracking studies should consider the trade-offs between development effort and subscription fees, as well as the anticipated number of participants and the level of data accuracy needed for their specific applications. While RealEye offers convenience and scalability for general use, WebGazer provides unparalleled customisation potential for advanced projects.

[1] Keskin, Merve, 2023, "CartoGAZE", https://doi.org/10.7910/DVN/ONIAZI, Harvard Dataverse, V1

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Table 1. Preliminary comparison table between WebGazer and RealEye

	WebGazer (static map exp., open-source)	**RealEye** (interactive map exp., comm.)
Initial Setup	Self-hosted web solution (requires programming skills).	Hosted web platform; quick setup, minimal coding needed for basic use.
Calibration or Gaze Accuracy	No built-in calibration; accuracy depends on proper implementation and external factors like lighting, webcam quality, and user positioning. Precise calibration is essential to reduce errors.	Built-in calibration module; still influenced by user environment factors (lighting, webcam position, etc.).
Stimuli & Experiment Design Flex.	Best for static maps with high customization, but requires significant effort for interactive tasks and may face accuracy challenges.	Suited for static maps with easier setup; interactive tasks possible but limited in flexibility.
Data Quality & Particip. Excl. Rates	High-quality data with careful setup, but may have higher exclusions due to calibration issues or poor webcam quality. Managing large data files can be challenging.	Generally reliable data with fewer exclusions; however, accuracy may decline for low-quality webcams or poor environments.
Ease of Use	Requires intermediate to advanced technical skills for custom integrations and data handling.	User-friendly web interface; lower technical barrier for most standard tasks.
Export Options	Raw data export supports detailed processing but requires custom scripts or tools like Python (Matplotlib, Seaborn), Excel, Tableau, or R for visualisations and reports.	Offers built-in export (in CSV format). Also, there is a possibility of exporting output videos with heatmap visualisations.
Additional Metrics Logging	It can be implemented via custom scripts; higher programming effort.	It can be implemented via custom scripts for own web pages; programming skills are needed.
Cost and Scalability	No license fees; you must consider development resources and potential server costs.	Subscription-based model; fees vary by plan but provide swift scalability and dedicated support.
Technical Support	Community support via forums, documentation, and GitHub, with options for self-troubleshooting or third-party help.	Dedicated customer support, faster response times and personalised help for higher-tier plans. Regular updates are included.
Participant Recruitment Integration	No built-in recruitment tools; relies on external platforms or manual methods like email, social media, or physical notices.	Offers participant recruitment tools and integration with higher plans, simplifying participant sourcing and management.
Updates and Maintenance	Relies on the OS community for updates; users manage updates and fixes manually.	Maintained by Real Eye with automatic updates included in the subscription.
Data Security and Privacy	Data security depends on hosting; users ensure GDPR compliance.	Managed platform with GDPR-compliant data security.
Performance Issues	Prone to interruptions or delays in complex self-hosted setups.	Rare performance issues due to the supported black box environment.
Best Suited for…	Developers, researchers, or teams that need maximum flexibility and are comfortable with programming and self-hosting.	Non-technical users or teams needing quick, reliable hosted solutions, but with a subscription fee.

In conclusion, this study advances webcam-based methodologies in geoinformatics and beyond by distilling these comparisons into best-practice guidelines. Our findings underscore the potential of webcam-based eye-tracking for both static and dynamic stimuli, providing researchers with actionable advice on how to use these tools effectively while navigating their inherent constraints.

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References

Fairbairn, D., & Hepburn, J. (2023). Eye-tracking in map use, map user and map usability research: what are we looking for? *International Journal of Cartography*, 9(2), 231–254. https://doi.org/10.1080/23729333.2023.2189064

Papoutsaki, A.; Sangkloy, P.; Laskey; Daskalova, N.; Huang, J. & Hays J. (2016), *Webgazer: scalable webcam eye tracking using user interactions*. In Proceedings of the Twenty-Fifth International Joint Conference on Artificial Intelligence (IJCAI'16). AAAI Press, 3839–3845.

Realeye.io. (2025). *Online Research Platform with Webcam Eye-Tracking | RealEye.io*. [online] Available at: https://www.realeye.io/ [Accessed 21 Jan. 2025].

Yang, X., & Krajbich, I. (2020). Webcam-based online eye-tracking for behavioral research. *Judgment and Decision Making*. https://doi.org/10.31234/osf.io/qhme6.

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