Improving biomedical diagnosis through light–based technologies and machine learning

VALIDATION OF A LAPTOP-WEBCAM-BASED EYE TRACKING SYSTEM FOR SACCADE MEASUREMENT

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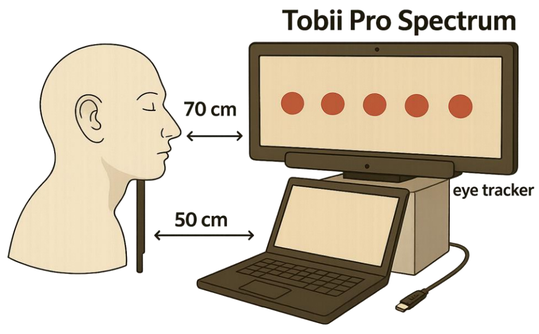
INTRODUCTION

- Deep learning (DL) is transforming eye-tracking technology by estimating gaze from eye appearance, enabling low-cost setups, greater head-movement tolerance, and minimal calibration.[1 2]

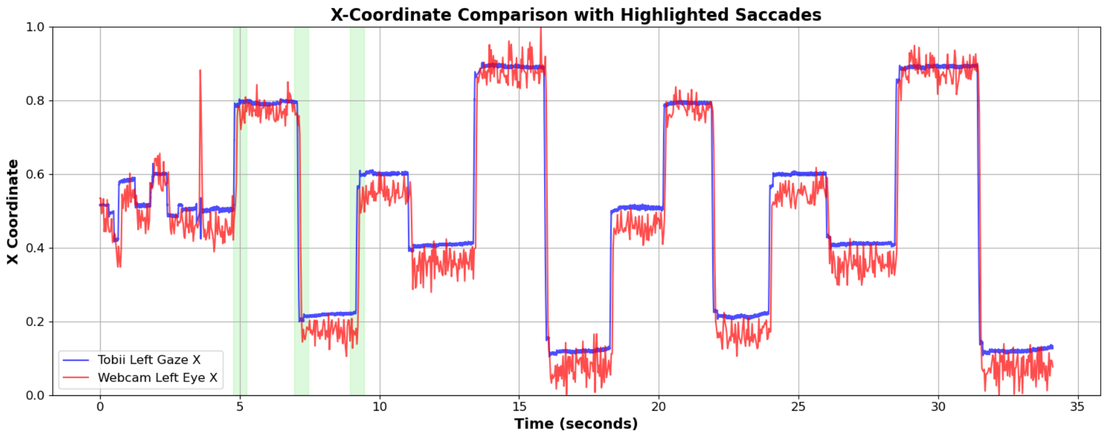
- **Goal:** To compare the performance of a DL laptop-webcam-based eye tracking system to detect and distinguish between saccades and fixations with a research-grade eye tracker (Tobii Pro Spectrum).

METHODS

- Binocular eye movements recorded from 8 healthy adults (28.12 ± 3.04 years) using a Tobii Pro Spectrum eye tracker (70 cm, @ 1200 Hz) and a laptop webcam (50 cm, @ 30 Hz). Head movements were restricted with a chinrest. Stimuli were presented on the Tobii screen (1920 x 1080 pixels; 52.8 x 29.7 cm).

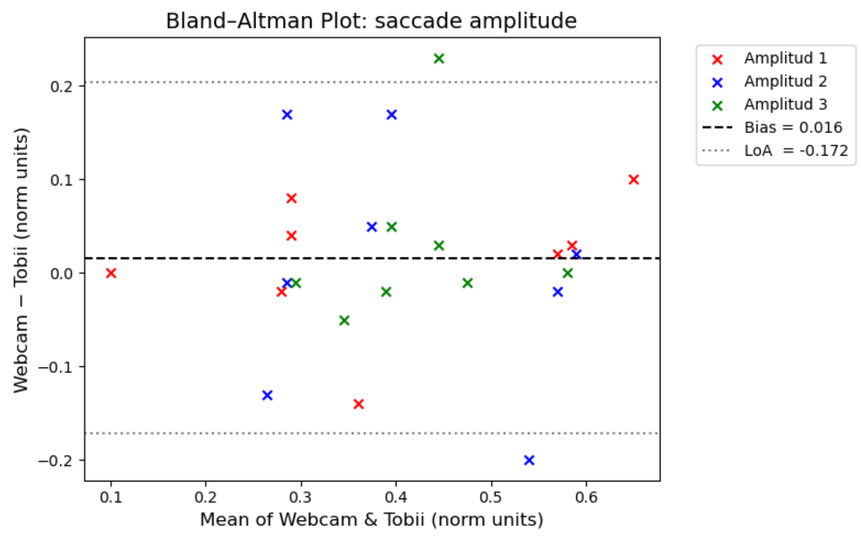


- Data were normalized to [0,1] relative to screen pixels and smoothed with a Savitzky-Golay filter. Eye velocities were derived from position differentiation, and saccades were detected using an adaptive velocity threshold algorithm.[3]



RESULTS

- The analysis included the amplitudes of saccades made in response to the first 3 stimulus' position changes [from the center of the screen (0.5 in normalized units, norm-units) to +15cm (0.78 norm-units), -15cm (0.22 norm-units) and +5cm (0.59 norm-units)].



- Bland-Altman analysis showed a bias of +0.016 norm-units with 95% limits of agreement from –0.172 to +0.208 norm-units.
- The webcam system agreed with the Tobii Pro Spectrum within ±0.19 norm-units in amplitude measurement for 95% of individual saccades, but the mean of webcam and Tobii Pro Spectrum measured amplitudes did not always match the expected ones.

Amplitudes (Norm-Units)	**Mean ±SD of differences in measured amplitude (Norm-Units)**
0.28	0.05 ± 0.04
0.56	0.09 ± 0.07
0.37	0.07 ± 0.04

CONCLUSIONS

- On average, amplitudes obtained with the webcam system matched those of a research-grade tracker, although we observed high variability among measured amplitudes. Future work will investigate its causes, expand the dataset, and assess spatial accuracy, precision, and resolution.

REFERENCES

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