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GazeDeck: Multi-Glasses Gaze Interactions on Arbitrary Cartographic Surfaces

Michaela Vojtechovska [a*], Stanislav Popelka [a]

michaela.vojtechovska01@upol.cz, stanislav.popelka@upol.cz

* Corresponding author

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Abstract:

Gaze-based interaction (GBI) offers a hands-free way to control maps, yet existing implementations mostly rely on stationary remote eye-trackers and nearly 90 % have been tested only on standard desktop screens (Vojtechovska et al., 2025). This desktop lock-in leaves GBI largely untested on projected wall displays, tablets in the field, or printed maps augmented with projected gaze overlays, all settings where cartographers and their audiences routinely work. We introduce GazeDeck, a standalone proof-of-concept application that brings mobile eye-tracking glasses to arbitrary cartographic surfaces with minimal setup, while aiming to provide the quality-reporting infrastructure that cartographic GBI studies have so far lacked (Figure 1). Its architecture combines three components:

- **Surface detection.** AprilTag fiducial markers are placed around the target surface. The glasses' scene camera detects them in the video stream, and a homography computed from their known positions transforms raw gaze coordinates into the surface coordinate system.
- **Multi-glasses connectivity.** Multiple pairs of Pupil Neon eye-tracking glasses connect over Wi-Fi; each pair is independently registered against the same or different surfaces.
- **WebSocket streaming.** Transformed gaze coordinates are streamed through a WebSocket-based architecture originally developed for stationary trackers in a dyslexia intervention system (Dostálová et al., 2024) and re-engineered here for wearable devices, making them available to any WebSocket-capable client: web geovisualisations, projected-display controllers, or custom applications.

Figure 1. Proof-of-concept setup. Two participants wearing Pupil Neon eye-tracking glasses view a web map on a monitor. AprilTag markers around the screen perimeter provide spatial registration. Coloured circles appear as dwell-triggered pings, alerting the other participant to a point of interest.

Because registration is surface-agnostic, GazeDeck extends established interaction techniques to surfaces that desktop eye-trackers cannot reach. Gaze gestures (Drewes and Schmidt, 2007) (e.g. a down / up / centre sequence for zoom out)

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serve as discrete zoom commands. Edge-panning (Stellmach and Dachselt, 2012) triggers continuous map scrolling when gaze falls beyond the surface boundary. For collaborative gaze sharing (Pfeuffer et al., 2021), each participant's gaze appears as a colour-coded dot on the shared map; a dwell-triggered ping enlarges it into an animated circle, alerting others to a point of interest. The same overlays can be projected onto a printed map with an overhead projector, AprilTag registration ensuring alignment with the physical content, a use case that, to our knowledge, has not been explored in the cartographic GBI literature (Vojtechovska et al., 2025).

A preliminary user study ($n = 13$) evaluating gaze gestures and edge-panning, together with informal testing at a public science fair (Noc Vědců), indicate high hedonic quality, though pragmatic quality scores remain below traditional input, an expected outcome for a proof of concept focused on basic GBI functionality rather than optimised usability. Development beyond this stage targets three directions: a quality-characterisation layer logging end-to-end latency, spatial accuracy, calibration drift, and gaze data loss rate; IMU-based interpolation between scene-camera frames to raise the effective gaze rate beyond the current 30 to 60 fps limit; and controlled user studies with interaction designs targeted at improving pragmatic quality alongside the already promising hedonic scores. The presentation will demonstrate the running system through video recordings and discuss both the preliminary findings and the planned extensions.

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