

Article Overview

Anti-tracking labeling in rail transit eye-tracking systems involves techniques to anonymize or obscure gaze data to protect passenger and operator privacy while maintaining operational safety and interface monitoring.

Overview of Eye-Tracking in Rail Transit

Eye-tracking cameras in rail transit are increasingly used to monitor operator attention, fatigue, and situational awareness, similar to applications in automotive and aviation sectors . These systems typically employ infrared cameras or wearable sensors to capture gaze direction, blink rate, pupil dilation, and fixation duration, providing insights into operator focus and interface usability . Such data can enhance safety, optimize control panel layouts, and improve human-machine interaction.

Privacy and Anti-Tracking Considerations

In rail transit, privacy concerns arise because eye-tracking data can reveal sensitive information about operators or passengers, including attention patterns, cognitive state, or even identity . Anti-tracking labeling refers to methods that prevent unauthorized tracking or identification while still allowing the system to function effectively. Key approaches include:

- o Data Anonymization: Removing or masking personally identifiable features from gaze data, such as facial landmarks or unique eye movement patterns, before storage or transmission .
- o Spatial and Temporal Aggregation: Aggregating gaze points into heatmaps or zones rather than recording precise coordinates, reducing the risk of individual identification .
- o Edge Processing: Performing gaze analysis locally on the device rather than transmitting raw data to central servers, minimizing exposure of sensitive information .
- o Synthetic Labeling: Using artificial or randomized gaze markers in datasets for training or testing purposes, which prevents real operator tracking while maintaining system calibration .

Implementation in Rail Transit

For rail transit operators, anti-tracking labeling can be integrated into driver monitoring systems (DMS) or control room simulators. For example:

- o HUD and Interface Optimization: Gaze heatmaps can be anonymized to show which controls or displays attract attention without linking data to specific operators .
- o Fatigue and Attention Monitoring: Real-time alerts can be generated based on aggregated gaze metrics rather than individual tracking, ensuring safety while preserving privacy .

Anti-tracking labeling for eye-tracking cameras used in rail transit

o Regulatory Compliance: Systems can be designed to comply with privacy regulations, such as GDPR in Europe, by implementing anonymization and data minimization strategies .

Future Directions

Advances in AI and deep learning allow for joint modeling of gaze patterns and visual context while supporting privacy-preserving techniques . Transformer-based architectures and semi-supervised learning can enable accurate attention monitoring without storing identifiable gaze trajectories, making anti-tracking labeling more robust and scalable for rail transit applications. In summary, anti-tracking labeling in rail transit eye-tracking systems balances operational safety and interface optimization with privacy protection, using anonymization, aggregation, edge processing, and synthetic labeling to prevent unauthorized tracking while maintaining the utility of gaze data .

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Collectively, these studies highlight the dual role of eye-tracking as a research instrument and as a core enabler of

Discover the main types of eye tracking devices, how they work, and their applications in

Hier sollte eine Beschreibung angezeigt werden, diese Seite lässt dies jedoch nicht zu.

Eye tracking is the systematic process of monitoring eye movements to determine where and for what duration an

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These characteristics open new opportunities for tasks like pupil tracking. The HDR capability of ECs allows them to

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In this article, we'll discuss eye tracking, or gaze estimation, technology, its potential to revolutionize

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A discussion of the current limitations will be provided to identify the shortcomings of state of the art in eye tracking and

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